ENVIRONMENTAL BASELINE (in the action area)

The Long-term Sustained Yield (LTSY) projections used to establish the environmental baseline and evaluate impacts on covered species include some differing assumptions regarding the Grizzly Creek complex than what is assumed in these biological and conference opinions. The LTSY projections assume that the 250 acres of the core habitat in the Grizzly Creek complex will be purchased and not available for harvest. For the purposes of analyzing impacts to all covered species except the marbled murrelet, these biological and conference opinions assume that all of the Grizzly Creek complex would be harvested after 5 years.

Baseline common to all species

Factors affecting species and suitable habitat in the action area

Other completed or contemporaneous actions

Other completed and contemporaneous actions include approved HCPs and THPs. The Simpson Timber Company (Simpson) HCP and its associated ITP (Simpson Timber Company 1992) has been approved in the action area. The permit area covers approximately 456,000 acres of land, of which 29,069 acres are in the action area. The ITP , approved in 1992 for the incidental take of northern spotted owls, will extend for 30 years. The Simpson HCP is expected to result in take of 50 owl sites, due to loss of suitable habitat in the first 10 years of the permit. Simpson anticipates a harvest rate of about 3,000 to 5,000 acres per year, with clearcutting as the primary harvest method.

Two measures are expected to mitigate the effect of take: measures to maintain owl habitat; and regrowth of habitat on previously cut areas. At least 40,000 acres of suitable spotted owl habitat will be maintained for at least 10 years. This acreage includes a special management area of over 30,000 acres which contain a cluster of at least 16 known owl sites, and an additional 13,000 acres of widely scattered lands which currently contain over 35 nest sites or activity centers. A small net gain in suitable owl habitat is expected to occur during the first 10 years of the permit, offsetting some, if not all, of the anticipated take. The amount of suitable owl habitat at the end of the 30-year permit period will be over twice the present amount, due to ingrowth of suitable habitat.

A number of approved or pending THPs occur in the action outside of the PALCO lands (California Department of Forestry and Fire Protection 1999). Data on the acreage of these THPs is only available for three of 19 Calwater watersheds found in the action area: Scotia, Eureka Plain, and Mattole River watersheds. Approved or pending THPs encompass a total of 20,341 acres in these watershed, the majority (15,706 acres, 77 percent of total) being attributed to either clearcut or shelterwood prescriptions (table 16). These THPs generally encompass a small percent of the watershed area found in the action areas: Scotia - 3 percent; Eureka Plain - 20 percent; and Mattole River - 9 percent.

Table 16. Approved (Appr.) and pending (Pend.) THPs within the action area outside of the PALCO lands.

Watershed			Harvest prescriptions						
			Clearcut		Shelterwood		Selection		
	Total ac.	Ac. in action area	Appr.	Pend.	Appr.	Pend.	Appr.	Pend.	Total
Scotia[1]	123,533	77,406	145	0	70	0	114	0	329
Eureka[1] Plain	52,450	12,813	4,730	81	7,250	4	3,091	5	15,161
Mattole[2] River	238,481	52,862	1,480	188	1,718	40	1,304	121	4,851
Subtotal:			6,355	269	9,038	44	4,509	126	
Total:			6,624		9,082		4,635		

[1] Based on data from 1988 to 1999.

[2] Based on data from 1983 to 1998.

HRSP and GCSP both occur in the action area and are directly adjacent to PALCO lands. These parks are expected to provide large blocks of LSH throughout the life of the permit. The parks consist primarily of coastal coniferous forests and total approximately 52,068 acres. HRSP is the larger of the two parks, and currently contains approximately 21,534 acres of old-growth habitat. GCSP is approximately 268 acres in size, most of which is considered to be LSH.

Baseline common to Pacific salmonids

Based on GIS information provided by PALCO and additional information supplied by CDFG, preliminary estimates in the Final EIS/EIR identify approximately 264 miles of Class I waters, 752 miles of Class II waters, and 576 miles, possibly as high as 3200 miles, of Class III waters within the action area. The Headwaters Forest Preserve contains less than 61 miles of streams of all stream classes. Using the CFPR definition of a watercourse and lake protection zone (WLPZ) to compute total acres within this zone, the Final EIS/EIR calculated that there are 18,172 WLPZ acres (including Elk River property) out of 209,803 total acres (9 percent) of PALCO lands and 39,754 WLPZ acres out of 949,963 total acres (4 percent) in the six watersheds of which PALCO property is a part (Final EIS/EIR, table S-15). The WLPZ-based measurements were calculated in the Final EIS/EIR using widths ranging from 75 to 150 ft for Class I waters, from 50 to 100 on Class II waters, and a standard 25 ft buffer for Class IIIs.

At a broad scale, coho salmon, chinook salmon, steelhead, and coastal cutthroat trout (hereafter referred to as Pacific salmonids) utilize similar habitat. Therefore, the status and distribution of habitat for these fish will be discussed collectively with additional, species-specific data provided where available.

Essential Habitat Features for Pacific Salmonids

The four Pacific salmonids, proposed to be covered under the ITP, have similar habitat requirements. The habitat factors that affect salmonid life cycle requirements include, but are not limited to, water quality variables such as temperature and turbidity, and physical habitat elements such as the presence and abundance of LWD, pool frequency and quality, channel condition, access, and riparian vegetation. During development of the draft and proposed final SYP/HCP, and draft and Final EIS/EIRs an interagency team, lead by NMFS developed a method of evaluating the functional potential and current conditions of individual environmental factors and watersheds necessary for salmonid life history requirements. This method is based on the March 20, 1997 Draft Aquatic PFC Matrix (Matrix; NMFS Draft 1997), which includes a set of aquatic, riparian, upland, and watershed elements with corresponding "properly functioning" values (Final EIS/EIR, appendix K). These values represent the best available information, at the time of development, for defining the biological requirements of Pacific salmonids in terms of environmental factors necessary for sufficient pre-spawning survival, egg-to-smolt survival, and upstream/downstream migration survival rates to ensure survival and recovery of the Pacific salmonids in northern coastal California. The Matrix also includes values for limiting factors, also referred to as threats, to functioning habitat, such as watershed disturbance, roads, and physical barriers. The discussion on threats to habitat appears later in this document. Refer to the Matrix for further discussion of the scientific basis for the PFC values. These PFC elements also closely correspond to the essential habitat features identified for proposed coho and chinook salmon critical habitat. The following information are brief discussions of the general habitat requirements of Pacific salmonids.

Water quality

Favorable water quality is an important component of a properly functioning aquatic system. Changes in water quality can affect the survival and production of many fish and other aquatic species. Key water quality parameters affecting fish survival include water temperature, DO, turbidity, and nutrients. Specific information on water temperature from the action area and surrounding areas are available (Final EIS/EIR, table 3.4-5); however there is little or no consistent information on DO, turbidity, or nutrient levels. For properly functioning habitat, cool water temperatures, clear water, adequate DO, and low levels of turbidity and nutrients are vital.

Water Temperature

Water temperature is perhaps the most influential water quality variable on salmonids (Spence et al. 1996). Stream temperature is influenced by many factors including latitude, altitude, season, time of day, water flow, channel width and depth, groundwater flow, stream shading from topography or vegetation, and coastal fog (MacDonald et al. 1991). The climate along the coast (i.e. Humboldt WAA) is cooler due to the fog influence, which also helps maintain cooler water in these areas (National Weather Service 1998).

Increased water temperatures can obstruct adult migration and limit spawning success, trigger early juvenile out migration resulting in decreased survival rates (Beschta et al. 1987), change juvenile sheltering behavior (Taylor 1988), reduce disease resistance, and increase metabolic requirements (Beschta et al. 1987). Water temperature fluctuations and their relationship to dissolved oxygen can affect all aspects of salmon and trout life histories in freshwater, from incubation and egg survival in stream gravels to the emergence, feeding, and growth of fry and juvenile fish, to adult migration, holding, and resting pre-spawning and spawning activities, and out migration of young fish. A rise in water temperature increases the metabolic rate of aquatic species such as salmon and trout, and temperatures in the range of 70□F or greater can cause death within hours or days (DEQ 1995).

For salmonids within the action area, water temperatures should be no higher than 53.2□-58.2□F to meet late summer juvenile rearing needs. Temperatures have been measured in the five main WAAs on PALCO's land and are provided in the Final EIS/EIR, table 3.4-5.

Sediment/Turbidity

Turbidity and suspended solids in surface water affects the primary productivity on which salmonids depend by influencing phytoplankton abundance, algal productivity, and plant species composition. Values for sediment are broken down into fine sediment less than 0.03 inches and sand particles less than 0.25 inches. For healthy salmonid habitat, the percent of particles less than 0.03 inches should be less than 11-16 percent. The percent of particles less than 0.25 inches should be less than 20-25 percent.

Excessive levels of fine sediment (<0.03 inches) can infiltrate redds and increase intergravel mortality of salmonid embryos (reviewed in Spence et al. 1996). Excessive levels of sand particles less than 0.25 inches can cap redds, reducing embryo survival and impeding the emergence of alevins (reviewed in Bjornn and Reiser 1991). Siltation reduces the diversity of aquatic invertebrates by reducing the interstices in the substrate (Spence et al. 1996). Excess sedimentation diminishes pool quality and quantity, increases turbidity, smothers salmon eggs and larvae, causes gravel embeddedness, and disrupts social and feeding behavior (Hicks et al. 1991, Spence et al. 1996).

Nutrients

Nutrient levels should remain within the natural range for specific areas and seasons in order to sustain normal levels of primary productivity to ensure adequate food resources for salmonids. Various inorganic constituents of surface water are nutrients required for biological processes. Nitrogen and phosphorus are the most important nutrients affecting productivity in stream systems (Spence et al. 1996). A summary of the literature on natural sources of nitrogen and phosphorus in stream systems can be found in Spence et al. (1996).

Nitrogen, phosphorus, and other nutrients can also enrich surface waters if concentrations are in excess of the natural range. Enrichment can lead to high phytoplankton and benthic invertebrate production. Too much enrichment can cause algal blooms, which may lead to oxygen depletion in the water which can inhibit growth and development of salmonids and also be lethal to all life stages.

Physical Habitat Elements

The physical structural elements of a stream system, such as LWD, substrate, pools, and lateral habitats (side channels, off-channel habitats) provide suitable aquatic habitat for salmonids as well as many organisms on which the salmonids depend. Substrate provides spawning habitat for salmonids. For successful spawning, egg incubation, and fry emergence, salmonids require an adequate amount of substrate within a specific size range and with a minimum amount of fine sediments (Spence et al. 1996). Woody debris regulates sediment and flow routing, influences stream channel bedform and bank stability, and provides hydraulic refugia and cover within stream systems (Bilby 1984, Gregory et al. 1987, Hogan 1987, Keller and Swanson 1979, Keller et al. 1995, Lisle 1983, Nakamura and Swanson 1993, Sedell and Beschta 1991). Woody debris creates and influences pool-riffle bedforms, backwater and edgewater habitats, and cover that provide adult spawning and holding habitat, juvenile summer and overwintering habitat, and refuge habitat from high velocities and predation (Bisson et al. 1992; Sullivan et al. 1987). Pool habitats are used by salmonids for both summer and winter rearing. Pools, especially those created by LWD, provide cover from predators, cooler temperatures, and refuge habitats during storm events (Everest et al. 1985). Off-channel habitats, where they exist, are also important rearing habitat for juvenile salmonids (Spence et al. 1996).

Substrate

A certain amount of bedload material is necessary to provide substrate for cover and spawning habitat for fish. For example, anadromous salmon typically use gravels ranging from 0.5 to 4 inches, whereas steelhead and resident trout may use smaller substrates ranging from 0.25 to 4 inches (Bjornn and Reiser 1991). Excessive amounts of sediment lead to instability, pool filling by coarse sediment, or introduction of fine sediment to spawning gravel (Spence et al. 1996). The quality of spawning substrate is ascertained by determining the median particle size (D50). Knopp (1993) suggests a D50 of 2.6 to 3.7 inches for northern California coastal substrates.

According to study results and summaries from Peterson et al. (1992) and Chapman (1988), substrates should contain less than 11 to 16 percent particles smaller than 0.03 inches to be suitable, and therefore functioning salmonid habitat. Field information collected by CDFG (1997) and PALCO (1998) shows a wide range of fine sediment levels for streams within the Action Area (R2, 1998). Sites that had greater than 20 percent fines (particles smaller than 0.033 inch) were found in majority of the planning watersheds studied. In laboratory studies, a substrate containing 20 percent fines was found to reduce emergence success of young salmon and trout by 30 to 40 percent (Phillips et al. 1975, MacDonald et al. 1991).

Fine sediment (0.004 to 0.033 inches in diameter) can reduce substrate suitability by restricting sunlight penetration, and filling pores between the gravel, thus preventing the flow of oxygen-rich water to fish eggs that may be deposited in the gravel. Fine sediments and larger particles (up to about 0.27 inch or sand-sized fractions) can also smother fish eggs and developing young in the gravel. In addition, they may also clog pores or breathing surfaces of aquatic insects, physically smother them, or decrease available habitat (Spence et al. 1996, Nuttall and Bielby 1973, Bjornn et al. 1974, Cederholm et al. 1978, Rand and Petrocelli 1985). Decreases in quality and quantity of suitable substrates has been influenced by the excessive delivery of sediment to a stream include from erosion and mass-wasting events, and the presence of adequate streamside vegetation to filter fine sediment derived from hillslopes and road erosion.

Large woody debris

LWD includes trees and tree pieces greater than 4 inches in diameter and 6 feet long (Keller and Swanson, 1979, Bilby and Ward, 1989). LWD is one of the most important components of high quality fish habitat (Marcus et al. 1990) and is known to provide food and building materials for many aquatic life forms, provide cover for juvenile and adult fish, and is the primary channel-forming element in some channel types (Marcus et al. 1990). Woody debris also plays a key role in the retention of salmon carcasses (Cedarholm and Peterson 1985), a major source of nitrogen and carbon in stream ecosystems (Bilby et al. 1996). The value of LWD in providing aquatic habitat depends on stream size, tree species, and numerous other factors (discussed in detail in the Final EIS/EIR).

LWD affects many aspects of streams, including channel morphology, sediment storage, water retention, stream nutrient cycling, macroinvertebrate productivity, and fish habitat (Marcus et al. 1990, Lisle 1986, Swanson et al. 1984, Martin et al. 1998). More specifically, LWD also regulates sediment and flow routing, influences stream channel bedform and bank stability, and provides hydraulic refugia and cover within stream systems (Bilby 1984, Gregory et al. 1987, Hogan 1987, Keller and Swanson 1979, Keller et al. 1995, Lisle 1983, Nakamura and Swanson 1993, Sedell and Beschta 1991), thus influencing the formation of the spatial template within with salmonids exist (Sullivan et al. 1987, Vannote et al. 1980). This template includes pool-riffle bedforms, backwater and edgewater habitats, and cover that provide adult spawning and holding habitat, juvenile summer and overwintering habitat, and refuge habitat from high velocities and predation (Bisson et al. 1992, Sullivan et al. 1987). Pools formed by stable accumulations of LWD provide important habitat for rearing salmonids, particularly in winter (Heifetz et al. 1986; Murphy et al. 1986). LWD loadings are also important for salmonid survival at high flows (Robison and Beschta 1990). Coho salmon have been shown to benefit directly from the habitat cover and pools formed by LWD, particularly during juvenile rearing. Juvenile salmonid abundance is often directly related to the amount of LWD in a stream (Murphy et al. 1986).

LWD may also be beneficial to adult salmonids that use it for resting sites and escape cover. It can form areas of deposition as well as scour, which can enhance spawning through gravel sorting (Flosi and Reynolds 1994). In addition, it can trap and hold post-spawned fish carcasses, enabling more effective recycling of nutrients into the aquatic system (compared to carcasses that are washed downstream)(Cederholm and Peterson 1985). Increased numbers of coho salmon have been directly related to the amount of LWD available for use in a stream (Bisson et al. 1987; Murphy 1995). Large accumulations of LWD in streams in the form of logging slash, however, may be undesirable and may block fish passage in extreme cases. Logging slash may include larger tree branches and short sections of wood without rootwads. Much of this type of LWD floats and, therefore, can be unstable (Bryant 1980). Unstable accumulations of LWD can wash out and destabilize streambanks, potentially causing reductions in fish habitat and overall stream productivity.

The actual number of LWD pieces an size that would provide properly functioning habitat conditions depends highly on site-specific factors. Bilby and Ward (1989), describe the relationship between channel width to size, and number of LWD pieces in coastal streams. For example, a 15 foot wide channel should have 16 pieces of LWD per 100 feet, with a mean debris piece volume of 13 cubic feet. In contrast, a 50 foot wide channel would be expected to have only four pieces of LWD per 100 feet, with a mean debris piece volume of 100 cubic feet. Generally, to obtain or maintain adequate levels of LWD, the stream buffer conditions must provide recruitment through process including toppling, windthrow, and bank undercutting. Large wood, in the north coast streams, is also contributed from upslope and upstream areas by processes such as mass wasting and other erosion events (McGarry 1994). During attempts to account for the sources of LWD, McDade et al. (1990) could not account for the source of more than 47 percent of the LWD pieces in 39 stream reaches, which suggests that the source was from upslope or upstream.

The actual number of LWD pieces that would provide properly functioning habitat conditions depends highly on site-specific factors. NMFS views recruitment as the key to obtaining properly functioning levels of LWD instream. The goal is to maintain streamside buffers conditions that have a high potential to recruit LWD. NMFS (1997) identified generalized streamside buffers that should have at least 23.8 redwood trees per acre greater than 32 inches dbh, of which 17.4 trees should be greater than 40 inches. The numbers are slightly lower for Douglas-fir. These numbers were derived from Eyre (1980), Bingham (PSW, in. litt., 1991), and the California Board of Forestry (in litt. 1992) for tree sizes and numbers associated with old-growth conditions.

Pool frequency/quality

Pool quality and quantity are both important for properly functioning aquatic habitat. Beschta and Platts (1986) suggest that pool size, frequency, distribution and quality are dependent on the mechanism which form the pools, such as large wood or bedrock, and other physical characteristics, such as substrate, bank erodibility and stream depth. Keller et al. (1995) found in streams in northern coastal California that pools comprise greater than 20 percent of the total surface area for gradients less than 3 percent. Of these pools, over 90 percent are associated with LWD in a large wood controlled stream system. For steeper gradients, over 25 percent of the total stream surface area should be pool habitat, with greater than 50 percent associated with LWD. Generally, good quality pools are greater than one meter deep, provide good cover and cool water, and their volume is only minimally reduced by fine sediment.

Channel condition & dynamics

The condition and dynamics of the stream channel in which Pacific salmonids live affects the suitability of the aquatic habitat. Stream channel variables important to salmonids include the condition of the streambank, the condition of and connectivity with adjacent floodplains, and the channel width/depth ratio. Streambanks frame the stream channel; their dimensions and stability influence and are influenced by the flow of water and the erosional debris produced by the watershed (Rosgen 1996). Undercut streambanks provide habitat and cover for aquatic species. Unstable banks often result in increased sediment inputs from bank erosion, a loss of undercut bank habitat, and an overall increase in the instability of the stream channel. This instability may express itself in changes to the width/depth ratio of the channel. Wider, shallower streams lead to water temperature increases, increased vulnerability of salmonids to predation, a possible increase in the carrying capacity for age-0 fish, but a reduced carrying capacity for age-1+ fish (Hicks et al. 1991). Adjacent floodplains provide off-channel habitat for juvenile and adult salmonids and dissipates the energy of water during high flow events.

Off-channel areas that are hydrologically linked to the main channel should be maintained, in addition to overbank flows to maintain wetland functions and vegetative succession (NMFS 1996). Existing backwaters with cover and low energy areas should also be maintained to provide refugia for juvenile salmonids. Generally, at least 90 percent of the streambanks should be naturally stable; only 10 percent of banks should show signs of active erosion and the natural range of width/depth ratios should be maintained.

Flows & hydrology

Specific flow requirements for the four proposed covered salmonids vary with each species, life history stage, and time of year. Generally, if peak flows, base flow and flow timing characteristics are comparable to the natural range of flows in an undisturbed state, then the stream is expected to be functioning properly relative to flows. In order to accomplish function, the watershed should have no to a minimal increase in the drainage network due to human activities (NMFS 1996).

Habitat access

The ability of salmonids to access various habitats during different life stages is essential to completion of their life history. Anadromous salmonids migrate upstream to spawn. Juveniles move between habitats during summer and winter months as conditions change (i.e., to escape high summer temperatures or avoid high winter flows). Smolts migrate downstream into estuaries and salt water where the majority of growth occurs. Barriers, both human-caused and natural, interfere with the ability of salmonids to access particular habitats at certain life stages, and can affect the species survival. For habitat to function properly all human-made barriers present in the watershed should allow for upstream and downstream fish passage of all life stages.

Riparian Vegetation and Function

The riparian zone acts as the interface between the aquatic and terrestrial ecosystems. It provides critical functions such as LWD, shade, bank stability, organic inputs and nutrients, wildlife habitat, microclimate, and sediment control, but also moderates the effects of upslope processes (Spence et al. 1996). Riparian buffer integrity is therefore considered an essential habitat feature for properly functioning aquatic habitat. An important product of riparian vegetation is shade, which moderates water temperatures, as discussed previously. Riparian vegetation increases bank stability through root strength and by moderating current velocity during high flow events (Spence et al. 1996). Woody roots also promote the formation of undercut banks, an important habitat for many salmonids (Murphy and Meehan 1991). Riparian vegetation provides the majority of the energy for the food web in heterotrophic systems by providing the allocthonous inputs supporting aquatic macroinvertebrates (Cummins et al. 1983) and influencing the rate of nutrient spiraling (Gregory et al. 1987, Newbold et al. 1982). LWD is provided to stream systems from hillslope processes such as debris torrents (McGarry 1994), but predominantly from adjacent and upstream riparian vegetation. Riparian vegetation can also act to control sediment inputs from surface erosion (Spence et al. 1996). Depending on site features such as slope, soil type, and drainage characteristics, riparian vegetation and associated downed debris, duff, and litter can filter overland flows from adjacent hillslopes. Megahan and Ketcheson (1996) determined that overland sediment movement in the Idaho batholith was inversely proportional to obstructions (downed vegetation) on the hillside.

The ability of riparian areas to provide for essential habitat requirements decreases in proportion to increasing distance from the streambank. Air temperature and relative humidity are not significantly altered if buffer strips exceed 45 m (150 ft) in width in old-growth conditions (Chen et al. 1995, Ledwith 1996, Brosofske et al. 1997). Both McDade et al. (1990) and Van Sickle and Gregory (1990), reported that more than 90 percent of instream wood identified as coming from adjacent riparian sources came from within approximately one site potential tree height for Douglas-fir. Streambank stability is maintained if riparian stands are undisturbed within a distance of 0.5 to 1 site potential tree height (Sedell and Beschta 1991). Nutrient input and retention, litter fall (Gregory et al. 1987), and shade functions (Beschta et al. 1987) are also controlled by conditions within 0.5 to 1 site potential tree height from the channel. At distances greater than approximately one site potential tree height, the ability of riparian vegetation to provide these essential habitat requirements declines sharply.

To avoid adversely affecting salmonids activities within riparian areas adjacent to and above salmonid habitat mush provide for adequate canopy, streambank and near-stream stability, and allocthonous inputs (woody debris, litter, and nutrients). In addition, activities within the upstream reaches of the watershed must not significantly increase the amount of sediment delivered downstream or modify the rate and timing of runoff.

Existing Habitat Conditions in the Action Area

Based on aquatic WLPZ width, there are 18,172 WLPZ acres (including Elk River property) out of 209,803 total acres (9 percent) of PALCO lands and 39,754 WLPZ acres out of 949,963 total acres (4 percent) in the six watersheds of which PALCO property is a part. Most of PALCO's ownership has been used for commercial timber production of primarily redwood and Douglas-fir for the last 120 years. Lands adjacent to PALCO's property include large commercial timber operations, small commercial timber operations and other private parcels, public parks and reserves, and other government lands. Other uses of private lands include grazing, agriculture, and residential development.

Based in part on the boundaries of "planning watersheds" delineated by the State of California, stream systems in the action area have been divided into six major Watershed Assessment Areas (WAAs) encompassing approximately 854,900 acres (Final EIS/EIR, figure 3.4-2). Overall, PALCO owns approximately 209,834 acres or about 24 percent of the land in these six WAAs. A major portion of the ownership is in the Yager Creek drainage. The WAAs comprise 19 Hydrologic Units (HUs) and are further divided into 94 planning watersheds. Since most of the available information on habitat conditions is at the scale of HU or WAA, the following descriptions are presented at the WAA level. Additional information at the HU level that is pertinent to this Opinion is provided where available. Future watershed analyses will be required to accurately describe conditions at the planning watershed scale.

Data on the condition of salmonid habitat within the action area are incomplete, but the data that are available can provide some indication of habitat status. Data points cited herein roughly indicate only the upper and lower parameters for each habitat variable. Averages for watersheds or WAAs are provided where available. The information summarized here is not complete, but is provided to establish a basic understanding of the environmental baseline. In some instances, the data are several years old, therefore they may not be representative of current habitat conditions. Natural and human-caused events such as floods, fires, and continued timber harvesting and road construction have occurred since much of the data were collected. Many of these events impacted or continue to impact the aquatic habitat, therefore the actual baseline habitat condition is probably below what is represented by the information presented here. The methods for collecting the data were not assessed for this comparison. Further information on habitat conditions within the action area can be found in the Final EIS/EIR.

Existing stream habitat conditions on PALCO lands are currently affected by a wide range of factors including geophysical changes (e.g., earthquakes and associated uplifting), extremes of flow (e.g., flooding and low flow), existing geological conditions (e.g., erodible soils), and land use practices (e.g., timber harvest, grazing, urban development, road construction and operation, and gravel mining). Since 1989, the CDFG has conducted surveys of stream habitat conditions and fish populations within the five main WAAs in the action area. A summary of these data is provided in Table 5-2 of the Final EIS/EIR.

Mad River WAA

The Mad River watershed is the northernmost drainage in the action area (Final EIS/EIR, figure 3.4-2) and has its headwaters in the Six Rivers National Forest. In this watershed, the elevation ranges from sea level to about 5,000 feet. There is one dam on the Mad River, Mathews Dam at Ruth Reservoir, located at river mile 69. Precipitation at the headwaters of the Mad River averages about 60 inches per year, while at the mouth, near Arcata, the average precipitation is 40 inches per year. Estimates for the 100-year flood event are about 100,000 cubic feet per second, while 2-year flood is estimated at about 18,000 cubic feet per second. Diversions for municipal and industrial uses occur near the mouth, just above Arcata. Two HUs within this WAA contain PALCO lands: Butler Valley and Iaqua Buttes. PALCO owns approximately three percent or 1,805 acres of the Butler Valley HU, and four percent or 1,465 acres of the Iaqua Buttes HU. Drainage density, an indicator of stream vulnerability to sediment influx, is 3.8 and 5.6 miles per square mile for the Butler Valley and Iaqua Buttes HU respectively.

Soil types in both HUs in the Mad River WAA are primarily composed of soils considered as moderate to highly erodible and sensitive to disturbances. Approximately six percent are classified as highly erodible soils. The Butler Valley HU is identified as potentially the most erodible watershed in the Project Area, with almost 8 percent in the high category and about 33 percent in the moderate erosion category. Within the action area, the erosion hazard is considered high, about 10 percent; 39 percent of PALCO land is in the moderate erosion hazard category. The Iaqua Buttes watershed is also highly erodible, with 5 percent erosion hazard, and 35 percent moderate hazard. PALCO lands within the action area are notably more erodible than the basin average, containing about 11 percent high-erosion hazard and 59 percent moderate-erosion hazard.

Stream aquatic habitat limitations within this WAA are not described in the Final EIS due the small size of PALCO's ownership within it (3,586 acres), and the dispersed nature of the small parcels. The streams in this WAA are mainly either Class II or III, although approximately 0.6 and 2.9 miles are present in the Butler Valley and Iaqua Buttes HUs respectively. These streams flow into the Mad River, which is listed under section 303(d) of the Clean Water Act for sediment and turbidity problems. The stream miles on PALCO's ownership within the Mad River WAA are presented below in Table 17.

Table 17: Stream Miles on PALCO Lands within the Mad River WAA (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Butler Valley	0.6	6.1	3.9	10.6
Iaaqua Buttes	2.9	9.5	5.7	18.1
Totals	3.5	15.6	9.6	28.7

Humboldt WAA

This WAA is composed of four major south-east-northwest trending HUs that drain into Humboldt Bay (Final EIS/EIR, Figure 3.4-2). These HUs include from north to south: Jacoby Creek, Freshwater Creek, Elk River, and Salmon Creek. The upper portions of the Little South Fork Elk River and Salmon Creek watersheds form the proposed Headwaters Reserve. The elevation range within each watershed is similar, from sea level to about 1,900 feet. The total area of the Humboldt WAA is 128,448 acres, with about 30 percent in PALCO's ownership.

Because of it's proximity to the coast and the orientation of the valleys, the Humboldt WAA is affected more by coastal fog than other WAAs.

The rivers in this WAA are typified by relatively high gradients and large flows. Average annual precipitation ranges from 40 inches near Humboldt Bay to 60 inches in the higher elevations. The discharge records for these rivers are incomplete or missing altogether. Stream gages were located on Jacoby Creek and on the Elk River for a short time in the 1950s and 1960s. Based on similarity in climate, vegetation, and topography, runoff characteristics are believed to be comparable to similar-sized tributaries in other WAAs. The drainage density is approximately 3.7 miles per square mile.

Most soil types within the Elk River watershed are considered to represent a moderate surface erosion hazard. Only two percent of Jacoby Creek's watershed is owned by PALCO, whereas most of the headwaters of Freshwater Creek is under PALCO ownership. Freshwater Creek contains the highest percentage of soils (14 percent) in the Action Area considered to have a high potential for surface erosion. The erosion hazard rating for PALCO lands within Jacoby Creek is relatively low with 47 percent in the low category, and 52 percent in the moderate category. The erosion hazard rating within most of Freshwater Creek (79 percent) is also low, however 1 percent is classified as high or extreme hazard. The dominant geomorphic features in Jacoby Creek is debris slide/slope amphitheaters (80 percent), followed by translational/rotational slides (9 percent). In Freshwater Creek, the predominant feature is also debris slopes, but the proportion is much less at 38 percent.

Within the Elk River HU, PALCO and Elk River Timber Company own almost all of the upper four planning watersheds. The combined erosion hazard rating for both watersheds is relatively low, with 85 percent in the low-hazard category, and 14 percent of moderate hazard. The dominant geomorphic features in the Elk River drainage are debris slides, while the Salmon Creek watershed is composed almost entirely of debris slide slopes (93 percent).

Approximately 66 percent of the Elk River hydrounit, 56 percent of the Freshwater Creek hydrounit, and less than 5 percent of the Salmon Creek hydrounit are owned by PALCO. The stream miles on PALCO's ownership within the Humboldt WAA are presented below in Table 18.

Table 18: Stream Miles on PALCO Lands within the Humboldt WAA (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Elk River	21.5	49.2	49.4	120.1
Freshwater Creek	21.8	56.7	38.7	117.2
Jacoby Creek	0.0	1.6	0.9	2.5
Other	0.0	0.1	0.2	0.3
Salmon Creek	0.7	1.8	1.5	4.0
Totals	44.0	109.4	90.7	244.1

In the Humboldt WAA, the SYP/HCP reports that sediment particles less than 0.03 inches in size comprised from 15.2 percent to 48.1 percent of the substrate in Freshwater Creek. Sediment particles less than 0.18 inches comprised from 26.9 percent to 66.8 percent of the substrate in Freshwater Creek. Similar figures were found for Salmon Creek and Elk River. On average across the Humboldt WAA, particles less than 0.03 inches made up 26.6 percent of the substrate. Particles less than 0.18 inches made up 42.7 percent of the substrate. According to the SYP/HCP, average high temperatures during summer months ranged from 59.8□F in the South Fork Elk River to 66.3□F at the station in the Scout Camp planning watershed (North Fork Elk River). The seven-day average high temperature averaged 61.6□F across the Humboldt WAA. Road densities in this WAA vary widely. The Little South Fork of Elk River has 1.4 mile per square /mile of roads, while Graham Gulch, a tributary to Freshwater Creek, has 7.9 miles per square mile. According to the Final EIS/EIR, there are a total of 299.1 miles of existing roads within this WAA. IFR (1998) provides information on vegetation types based on Landsat images taken in 1994 and analyzed by the Humboldt State University Spatial Analysis Lab. According to IFR (1998), vegetation in the Humboldt WAA is mostly early to mid succession, except for a few sub-watersheds with a late-seral or old-growth component. In contrast, the SYP/HCP and Final EIS/EIR report that vegetation in the Humboldt WAA is in a mid to late-seral stage. This difference could be partially based on the dissimilar definitions for seral stages. Within the WLPZ's, there are 369 acres of young forest, 1,026 acres mid-seral, 1,128 acres late-seral, and 105 acres of old-growth forest in the Humboldt WAA (Final EIS/EIR, Table 3.7-8).

Within this WAA, both Freshwater Creek and Elk River have been listed under section 303(d) of the Clean Water Act as water quality limited due to sediment problems. Freshwater Creek and Elk River have also been listed by CDF as cumulatively affected for sediment problems. Instream habitat limitations include shallow mean pool depth, low instream cover levels, and a high level of fine sediment. Essential habitat features that are currently not properly functioning include sediment and temperature. There is inadequate information to draw conclusions on the condition of other essential habitat features.

Eel WAA

The Eel WAA is the largest WAA in the action area, consisting of 427,468 acres, with about 74,000 acres in PALCO ownership (Final EIS/EIR, figure 3.4-2). The PALCO lands are mostly within the middle and lower portions of the Eel River watershed, downstream of the junction with the South Fork Eel River. It should be noted that the WAA, as delineated in the Final EIS/EIR, does not include significant portions of the actual river basin. The entire river basin is 2 million acres. Elevations range from sea level to about 6,000 feet at the headwaters of the Middle Fork of the Eel River. Rainfall averages 60 inches per year at lower elevations, and reaches 110 inches per year at high elevations.

The headwaters of the Eel River are in the interior coast ranges in Mendocino and Trinity counties, and include three main forks plus the mainstem Eel River. An extensive study of sediment discharge within the Eel River watershed (Brown and Ritter 1971) determined that the suspended sediment discharge increases downstream, unlike most rivers. The average annual suspended sediment load is 10,000 tons per square mile (Brown and Ritter 1971), which is one of the highest sediment yields in the world.

Soils within this WAA are highly diverse, with the most erodible soils occurring within the Eel Delta HU (19 percent classified as highly erodible). Within the Lower Eel HU, a large debris flow emanated from harvested PALCO lands in 1997, destroying several homes. This HU has a relatively high proportion of erodible soils, with 3 percent in the high and extreme categories, and 41 percent in the moderate category. A study by Brown and Ritter (1971) estimated that approximately 68 percent of the annual sediment yield came from the middle sections of the Eel River, mostly upstream of PALCO's ownership.

Approximately 17 percent of the WAA is owned by PALCO. The stream miles on PALCO's ownership within the Eel WAA are presented below in table 19.

Table 19: Stream Miles on PALCO Lands within the Eel WAA (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Eel Delta	12.6	39.7	27.4	79.7
Giants Avenue	1.2	4.9	4.3	10.4
Larabee Creek	21.5	62.7	43.9	128.1
Lower Eel River	30.9	130.8	91.5	253.2
Sequoia	13.7	42.1	30.8	86.6
Totals	**79.9**	**280.2**	**197.9**	**558.0**

In the Eel WAA, the SYP/HCP reports that sediment particles less than 0.03 inches comprised 13.5 percent of substrate in Larabee Creek and 45.3 percent in Strongs Creek. Sediment particles less than 0.18 inches comprised 29.35 percent of substrate in Larabee Creek and 60.2 percent of substrate in Nanning Creek. The average level of fine sediment particles was 23.4 percent for particles less than 0.03 inches and 39.5 percent for particles less than 0.18 inches in the Eel WAA. According to the SYP/HCP, the maximum weekly average temperature (MWAT) for the Eel WAA ranged from 57.4□F in Strongs Creek to 74.0□F in Larabee Creek, with an average of 63.2□F across the whole WAA. Using data collected by the Humboldt County Resource Conservation District (RCD), IFR (1998) analyzed how many hours per week temperatures exceed 61□F, which was used as the upper threshold for temperature tolerance for coho salmon. Using this analysis, IFR (1998) reported that during the first week of August, 1997, 102 hours of above threshold temperatures were recorded in Jordan Creek. In Bear Creek, from the second week in July until the end of August 1997, temperatures were above threshold almost all the time (>155 hours per week), indicating that these streams may not be suitable for coho salmon. Woody debris surveys were completed for some streams within the Eel WAA. Surveyors found an average of 862 cubic feet per 100 feet of stream. The amount of pools was also reported the SYP/HCP. In the Eel WAA, the percent of pool habitat ranged from 14 percent in Monument Creek to 57 percent in North Fork Strongs Creek. The average for pools across the WAA was 26 percent. Because the gradient of the water where these measurements were taken is not noted in the SYP/HCP, it is difficult to judge the value of these data points. WLPZ acreage within the Eel WAA include 881 acres of young forest, 2,315 acres of mid-seral, 1,964 acres of late-seral, and 105 acres of old-growth forest (Final EIS/EIR, table 3.7-8).

Within this WAA, the Eel River has been listed under section 303(d) of the Clean Water Act as water quality limited due to sediment and water temperature problems. Bear, Jordan, and Stitz creeks, tributaries of the lower Eel River, have also been listed by CDF as cumulatively affected for sediment problems. Essential habitat feature limitations include high water temperatures, low instream cover levels, high sediment levels and low LWD abundance. There is inadequate information to draw conclusions on the condition of other essential habitat features.

Van Duzen WAA

The Van Duzen River is a tributary to the Eel River (Final EIS/EIR, figure 3.4-2). Its mouth is about 4 miles downstream from Scotia. As defined in the Final EIS/EIR, the WAA excludes the headwaters of the Van Duzen, and consists of about 55,400 acres. However, the total area of the Van Duzen watershed is about 189,000 acres; 25,000 acres is owned by PALCO. The Van Duzen River flows northwest from its headwaters, then turns west and flows through deeply incised valleys that have an average slope of 59 feet per mile (1.1 percent). Bank cutting and slides are common along the Van Duzen River between Carlotta and Bridgeville. Although the elevation of the entire watershed ranges from near sea level to 5,000 feet, the portion on PALCO lands is relatively low. Some planning watersheds within the Van Duzen WAA include Cummings, Hely, Stevens, Root, and Grizzly creeks.

Average annual precipitation in the Van Duzen WAA is 64 inches, while average annual runoff is 995,000 acre-feet at Bridgeville. The average annual suspended sediment load is 6,760 tons per square mile (1941 to 1975). Stream density is 3.4 miles per square mile.

Soils in this WAA are more diverse, but include about eight percent of highly erodible soils in the Hely Creek watershed. Kelsey (1980) demonstrated that small areas can be significant contributors of sediment and may be more important than the areal extent of geomorophic features. For example, Kelsey (1980) demonstrated that 73 percent of the sediment input to the stream comes from fluvial surface erosion of hillslopes on 4.5 percent of the Van Duzen River watershed. While this study was located in the Van Duzen watershed, the similarity of parent materials and geomorphic features within the action area suggests that similar natural denudation rates are occurring elsewhere.

Approximately 45 percent of the Van Duzen WAA is owned by PALCO. The stream miles on PALCO's ownership within the Van Duzen WAA are presented below in Table 20.

Table 20: Stream Miles on PALCO Lands within the Van Duzen WAA (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Van Duzen River	30.4	83.3	65.7	179.4

The SYP/HCP reports that fine sediment less than 0.03 inches comprised 16.7 percent of substrate in Hely Creek, but up to 36.0 percent of substrate in Root Creek. For particles less than 0.18 inches, Hely Creek again had the least amount of fine sediment, 29.5 percent, compared to Root Creek, which had 48.2 percent. On average across the WAA, fine sediment less than 0.03 inches comprised 29.0 percent of substrate, while particles less than 0.18 inches comprised 43.4 percent. Temperature measurements in the Van Duzen WAA come from multiple sources. The SYP/HCP reports temperature data from Cummings Creek and Root Creek only. For those subwatersheds, the average MWAT was 59.7□F, and the seven-day average high was 62.6□F. Using data collected by the Humboldt County RCD, IFR (1998) noted that in Cummings Creek in August 1997, temperature gauges recorded up to 115 hours per week of temperatures above the threshold. In Grizzly Creek, during July, August, and September, temperatures were sustained above the threshold nearly 24-hours a day for eight straight weeks. Woody debris measurements from the Van Duzen WAA in the SYP/HCP are from Grizzly, Hely, and Root Creek. Across the watershed, PALCO found an average of 499 cubic feet of LWD per 100 feet of stream. Information on pools also comes from the SYP/HCP. On average, pools only make up 17 percent of the stream surface area in the Van Duzen WAA. Road densities in this watershed are variable, from 2.9 miles per square mile of road in the Cummings Creek watershed to 5.5 mi/mi^2 in both Root and Grizzly Creek watersheds. Current WLPZ acreage within the Van Duzen WAA includes165 acres of young forest, 1,179 acres of mid-seral, 378 acres of late-seral, and six acres of old-growth forest (Final EIS/EIR, table 3.7-8).

Within this WAA, the Van Duzen River has been listed under section 303(d) of the Clean Water Act as water quality limited due to sediment problems. Essential habitat feature problems include high levels of sediment, low percent of pools, high water temperatures, and low instream cover levels. There is inadequate information to draw conclusions on the condition of other essential habitat features.

Yager WAA

Yager Creek is a tributary to the Van Duzen River (Final EIS/EIR, Figure 3.4-2). The area of the WAA is approximately 85,000 acres, and over one-third is under PALCO ownership. Yager Creek flows from its headwaters, mostly in prairie lands, generally westward through deep valleys, with vegetation changing to redwood forest. Like many rivers in the Coast Range, it is entrenched and flows along small meanders. Two main forks, the North Fork and South Fork of Yager Creek, are present in the east portion of the watershed and are mostly outside of PALCO's ownership. Another tributary of equal importance is Lawrence Creek, which flows north to south and joins Yager Creek downstream of the junction of the North and South forks.

Larger HUs within the WAA include Lawrence Creek and the North, Middle, and South forks of Yager Creek; some planning watersheds include Strawberry, Blanton, Allen, and Cooper Mill creeks. Elevations range from near 400 feet to about 3,200 feet. Stream density is relatively high, at 3.8 miles per square mile. Being farther inland, the Yager Creek WAA is influenced very little by coastal fog. There are very little water and sediment discharge data for Yager Creek. However, based on the general physiography, climate, and location of the creek, it can be assumed to be hydrologically analogous to similar-size watersheds in the vicinity (e.g., Bear River).

Soil types in this WAA are fairly similar across HUs and are considered to represent a moderate to high surface erosion hazard. The lower sections of this WAA contain a nearly unbroken string of debris slides and shallow slumps along the inner gorge of the mainstem. Lawrence Creek is estimated to have 90 percent low erosion hazard ratings, and is considered one of the most relatively stable HUs in the action area with only 32 percent of the land being designated as having geomorphic features related to landslides. On the other hand, even though the North Fork Yager Creek have a 76 percent low and 22 percent moderate erosion hazard rating, and the HU has the lowest percentage of landslide-related geomorphic features in the action area, gullying in the prairie lands within the watershed is extensive. The Middle Fork Yager Creek (of which only 3 percent is owned by PALCO) is rated as low (93 percent) to moderate (7 percent). Lower Yager, which is owned mostly by PALCO, contains approximately 83 percent debris slide slopes, three percent earth flows, two percent inner gorges, and is considered to have a high erosion hazard rating relative to the other HUs.

PALCO owns approximately 40 percent of the land within the Yager WAA. The stream miles on PALCO's ownership within the Yager WAA are presented below in Table 21.

Table 21: Stream Miles on PALCO Lands within the Yager WAA (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Lawrence Creek	25.6	55.9	41.7	123.2
Lower Yager River	19.6	51.6	46.7	117.9
Middle Yager River	7.2	6.2	6.3	19.7
North Yager River	3.5	9.2	7.5	20.2
Totals	55.9	122.9	102.2	281.0

The SYP/HCP reports that in the Yager WAA, fine sediments less than 0.03 inches ranged between 7.1 percent of substrate in Booths Run planning watershed and 26.9 percent in Shaw Creek. The average for the whole WAA was 16.3 percent. For sediment particles less than 0.18 inches, the SYP/HCP reports sediment levels between an average 23.9 percent of substrate in Booths Run planning watershed and an 44.7 percent in the Bald Jessie (South Fork Yager) planning watershed. On average across the WAA, particles less than 0.18 inches comprised 36.1 percent of the substrate. Using data collected by the Humboldt County RCD, IFR (1998) noted that in Lawrence Creek in 1997, from the last week in June through the first of September, temperature gauges recorded over 150 hours per week of temperatures above the threshold. The SYP/HCP has only a few temperature data points for the Yager WAA. In Bell Creek, the seven-day average high was 60.4°F and the MWAT was 58.8°F. In the Lawrence Creek planning watershed, the seven-day average high was 68.4°F and the MWAT was 63.0°F. The SYP/HCP also provided information on pools for the Yager WAA. Pools made up 45 percent of the stream surface area in Lawrence Creek, but only 16 percent of the Bald Jessie planning watershed. Road densities within the Yager Creek watershed range from 4.9 miles per square mile to 6 miles per square mile, with one station in the Bell Creek drainage with 7 miles per square mile. Vegetation types from IFR (1998) were based on Landsat images taken in 1994 and analyzed by the Humboldt State University Spatial Analysis Lab. For Booths Run planning watershed, the analysis shows a large medium and small tree component, with a very high shrub component, probably from clearcuts. The Bell Creek watershed exhibits similar composition. Lawrence Creek, in contrast showed a substantial medium and large tree component. Current WLPZ acreage within the Yager WAA includes 1,023 acres of young forest, 1,117 acres of mid-seral, 392 acres of late-seral, and 221 acres of old-growth forest (Final EIS/EIR, table 3.7-8).

Within this WAA, Yager Creek has been listed under section 303(d) of the Clean Water Act as water quality limited due to sediment problems. Essential habitat feature problems include low instream cover levels, high summertime water temperatures, and a high level of fine sediment. There is inadequate information to draw conclusions on the condition of other essential habitat features.

Bear/Mattole WAA
The Bear-Mattole WAA lies between the Eel River WAA and the coast. This WAA contains two major watersheds: the Bear River and the Mattole River. The area of the WAA is approximately 160,000 acres, of which PALCO owns 25 percent of the Bear River watershed and 7.5 percent of the Mattole River watershed. Both watersheds have a mixture of prairie and forest and are not significantly influenced by coastal fog due to their orientation relative to the coastline.

The Mattole River has two major forks: the mainstem and Bear Creek. Both flow northwesterly. The watershed is unique in that its headwaters (both forks) are a short distance from the ocean. The total length of the mainstem Mattole is 63 miles. The total area of the Mattole watershed is about 319,360 acres. Elevation ranges from sea level to 4,200 feet. In the upper reaches, the river flows through an open alluvial plain. Much of its length, however, is in entrenched meanders. Downstream of the junction with the North Fork Mattole River, the channel and valley narrow, and the river flows southwest toward the sea. PALCO's property is located within the North Fork Mattole River and the Upper North Fork Mattole HUs. The North Fork flows west and southwest in deep canyons of the Coast Range. The river and its tributaries are entrenched in their valleys and have numerous small meander ends. The Upper North Fork Mattole River flows roughly north-south, through deeply entrenched valleys, joining the Mattole at Honeydew.

Average annual precipitation in the Mattole River watershed is 40 inches near Cape Mendocino and reaches 90 inches near Shelter Cove. A small amount of water is diverted for irrigation. The Mattole River has an estimated 100-year flood of 99,000 cfs, while the two-year flood is about 40,000 cfs. Annual suspended sediment yield averages 9,517 tons per square mile. Stream density across the entire WAA is approximately 3.4 miles per square mile.

The Bear River is 24.3 miles long; it has a 66,000-acre drainage area and flows westward across the Coast Range to the Pacific Ocean. Elevation in the watershed ranges from sea level to just under 3,000 feet. There are not data on water or sediment discharge on the Bear River. However, its headwaters are underlain by a shear zone that is part of the Mendocino Triple Junction. It is likely that natural sediment production is high and probably similar in nature to the Mattole River.

In October 1996, the Mattole Sensitive Watershed Group nominated the Mattole River watershed for classification as a sensitive watershed under Title 14 of the California Code of Regulations. Their reasons included seasonally high water temperatures that have resulted in recorded mortalities of juvenile chinook salmon in the lower river, excessive fine sediments in streams, and depletion of late-seral forests in the watershed below minimum levels (i.e., less than 15 percent of total area). The nomination, which attributed these conditions to extensive timber harvest an road building in the watershed, was not accepted by the Board of Forestry.

With the assistance of professional geologists, 23 Mattole watershed residents performed their own erosion surveys and mapping. They found that roads, including logging haul roads and skid trails, were the source of 76 percent of all erosion problems mapped in the watershed (see

Mattole Restoration Council 1989). Elements of recovery: an inventory of upslope sources of sedimentation in the Mattole River Watershed with rehabilitation prescriptions and additional information for erosion control prioritization (MRC, Petrolia, CA).

The Bear-Mattole WAA contains a variety of soil types. Soils classified to have a moderate to high surface erosion hazard occur primarily in the North Fork Mattole and Bear River watersheds and Mattole Delta HU. The distribution of geomorphic features and erosion hazard ratings in this WAA is in concordance with the high rate of sediment production. On the North Fork Mattole, the main geomorphic feature is debris slide slopes (38 percent); the erosion hazard rating is eight percent extreme or high and 47 percent moderate. On the Upper North Fork, the main geomorphic feature is debris slide slopes (44 percent), followed by disrupted ground, inner gorges, and translational/rotational slides (each about 4 percent). The erosion hazard potential is 14 percent extreme and high and 49 percent moderate.

The Bear River has a 15 percent extreme and high erosion hazard rating and 43 percent moderate rating, making it the most erodible HU in the action area. Analysis of aerial photographs between 1941 and 1988 showed very few landslides in the areas that were not harvested. Most of these landslides were associated with roads. The dominant geomorphic features are debris slide slopes (34 percent), and translational/rotational slides (5.8 percent).

Approximately 19 percent of this WAA is owned by PALCO. Twenty-five percent of the Bear River hydrounit and 9 percent of the Mattole River hydrounit are owned by PALCO. The stream miles on PALCO's ownership within the Bear-Mattole WAA are presented below in table 22.

Table 22: Stream Miles on PALCO Lands within the Bear/Mattole River Watershed Area (from Final EIS/EIR).

Hydrologic Unit	Class I	Class II	Class III	Total
Bear River	22.6	58.8	45.6	127.0
Mattole Delta	5.0	10.2	9.9	25.1
North Fork Mattole River	5.0	17.7	15.0	37.7
Upper North Fork Mattole River	9.6	31.2	25.0	65.8
Totals	**42.2**	**117.9**	**95.5**	**255.6**

As reported in the SYP/HCP, fine particles less than 0.03 inches comprised 10.7 percent of substrate in Rattlesnake Creek and 22.3 percent in the North Fork Mattole River. In the Bear River drainage, particles less than 0.03 inches comprised 14.1 percent of the substrate. The average for this particle size was 16.7 percent across the whole WAA. For particles less than 0.18 inches, Bear River reported 26.4 percent. From the Mattole River drainage, values for this particle size ranged from 29.4 percent in Rattlesnake Creek to 39.9 percent in the Tent City watershed. The average for particles less than 0.18 inches across the whole WAA was 33.9

percent. As a measure of instream temperature values within this WAA, IFR (1998) noted that in 1996, temperatures in the mainstem Mattole River exceeded the threshold temperature for more than 150 hours a week from the last week in June through the end of August. The SYP/HCP reports that the seven-day average temperature in the Bear River drainage was 71.3□F and the MWAT was 64.0□F. For the Mattole River drainage, data were only reported for the Rainbow watershed in the North Fork Mattole. The seven-day average for that drainage was 72.0□F and the MWAT was 64.3□F. As reported in the SYP/HCP, the percentage of surface area covered by pools ranged from 11 percent of the stream surface area in the Tent City watershed to 34 percent of the stream surface in the Beer Bottle watershed. Within the whole WAA, pools covered an average of 16 percent of the stream surface area. Road densities throughout the WAA ranged from 1.9 miles per square mile in the Rattlesnake Creek drainage to 3.9 miles per square mile in the Green Ridge watershed. The vegetation type analysis from IFR (1998) shows that in 1994, the Rainbow watershed (East Branch North Fork Mattole River) had a substantial medium and large tree component, but also some shrub and grass areas that could indicate either clearcuts or natural meadows. IFR (1998) notes that there are substantial natural grass areas along ridgelines in this watershed. The Long Ridge watershed (North Fork Mattole River) had a high medium and large tree component, but also a substantial shrub and grass component. Again this could be either recent clearcuts or the natural meadows. The very large tree component for both watersheds was minimal. Current WLPZ acreage within the Bear/Mattole WAA includes 68 acres of young forest, 1,929 acres of mid-seral, 89 acres of late-seral, and 366 acres of old-growth forest (Final EIS/EIR, table 3.7-8).

Within this WAA, the Mattole River has been listed under section 303(d) of the Clean Water Act as water quality limited due to sediment and water temperature problems. In addition, due to sediment levels, CDF and CDFG have maintained a policy of "zero net discharge" of sediment to watercourses in the Mattole River watershed since 1992. The Mattole Sensitive Watershed Group (1996) also proposed the Mattole River as a sensitive watershed under the Forest Practice Rules because of excessive fine sediment and high water temperatures. Along with elevated water temperature and high sediment levels, essential habitat feature limitations in the Bear-Mattole WAA include high embeddedness, low percent canopy, low percent pools, and low percent instream cover. There is inadequate information to draw conclusions on the condition of other essential habitat features within this WAA.

Known or Suspected Factors Affecting Salmonid Habitat

Timber Harvest

Past and present timber harvest on both public and private lands have contributed to the degradation and destruction of salmonid habitat. Past harvest, on both public and private lands, has left a legacy of altered habitats that still require considerable time for recovery, and the Final EIS/EIR estimates that the return to historical conditions will probably never occur on a large proportion of the forest landscape. Timber harvest practices were not regulated in riparian zones until the 1970s; thus, there were more than 120 years of human activity and 50 to 70 years of intensive harvest before mandated consideration of streamside protection. Forest practices that contributed to the decline of riparian habitat include timber harvest to streambank; railroad and road building along the riparian corridors; and splash damming. Additionally, removal of LWD was a biologically recommended practice until the mid-1970s. All of these practices led to a considerable reduction in riparian zone function.

Timber harvest in the action area began with relatively simple, non-mechanized techniques at a fairly low rate of harvest. Until the turn of the century, river flats and adjacent slopes were clearcut using livestock and manpower. Around the turn of the century, steam-powered engines were used to drag logs to collection areas and little regard was given to the processes of erosion and mass wasting. Virtually no protection was given to fish or fish habitat. As a result, trees in the action area were knocked down by the dragging of other logs, and deep furrows were made by dragging the logs long distances across hillslopes.

Since streambeds and/or valley bottoms were commonly used as routes for moving these logs, removal of large woody debris from the streams, combined with extensive filling of the channels to make an even grade for train tracks, caused heavy damage to the streams. In other areas, "splash dams" were constructed by temporarily damming streams, and then dynamiting the dams sending a torrent of logs, debris, and water downstream. The resulting flood surge caused extensive damage to streams and riparian areas which persist in some areas.

Timber harvest rates increased dramatically in the 1960s involving clear-cutting techniques and creating widespread disturbances across entire watersheds. By the 1970s cable-yarding techniques were more prominent and clearcutting remained the dominant silvicultural practice. After passage of the Z'berg Nejdley Foresty Practices Act in 1972, forest practice rules were developed to help reduce the effects to sensitive watersheds, as a result some of the most damaging practices, such as splash dams and tractor use on steep slopes, were severely limited or curtailed. Even with these improvements to timber harvesting the forest practices of today still result, in many cases, in adverse effects to salmonid habitat and contribute to the overall problem of cumulative effects affecting the rate at which salmonid habitat may or may not improve.

Road Management

Roads have adversely affected salmonid habitat by increasing sediment loads, altering channel morphology and destablizing streambanks, modifying the drainage network, creating barriers to movement, and increasing the potential for chemical contamination (Furniss et al. 1991). Construction of road network networks has greatly accelerated erosion rates within watersheds (Beschta 1978, Reid and Dunne 1984, Swanson and Dyrness 1975, Swanston and Swanston 1976). Cederholm et al. (1981) reported that the percentage of fine sediments in spawning gravels increased above natural levels when more than 2.5 percent of a basin area was covered by roads. Roads and other areas of intentional surface disturbance are a chronic source of sediment to streams (Swanston 1991). Roads and related ditch networks are often connected to streams via surface flowpaths, providing a direct conduit for the sediment. Where these roads and ditches are maintained by periodic grading, chronic sediment delivery may be temporarily increased as bare soil is exposed and ditch roughness features which store and route sediment are removed. In steeper terrain, road construction has triggered landslide processes that deliver large amounts of sediment directly into streams, destabilize streambanks, and constrain the natural geomorphological migration of the stream channel (Furniss et al. 1991). Improperly maintained roads have failed or may fail, years after construction (Furniss et al. 1991). Road networks have affected hillside drainage; intercepted, diverted, and concentrated surface and subsurface flows, and increased the drainage network of watersheds (Hauge et al. 1979, Wemple et al. 1996). This has and can lead to changes in peak and base flows in streams. Steam crossings have restricted channel geometry and prevented or interfered with migration of adult and juvenile salmonids (Furniss et al. 1991). Crossings have also be a source of sedimentation, especially when they have failed or become plugged with debris, causing debris torrents and significant cumulative impacts downstream (Furniss et al. 1991, Murphy 1995).

Hagans and Weaver (1987) found that fluvial hillslope erosion associated with roads in the lower portions of the Redwood Creek watershed produced about as much sediment as landslide erosion between 1954 and 1980. Similar results are reported by Best et al. (1995), attributing most of the sediment to stream diversions at crossings.

Since roads are a major source of sediment, the miles of road per unit area (equal to road density) and number of stream crossing per mile provides a crude estimate of the potential condition of a watershed. Road densities in the action area are presented in table 3.6-18 of the Final EIS/EIR. These numbers do not include skid trails or older roads that are not currently used. Seven of the HUs have road densities higher than 5 miles per square mile, and only two have road densities under 2 miles per square mile. Stream crossings per mile on PALCO's ownership range from a low of 3.1 in the North Fork Mattole River HU to a high of 17.7 in the Eel Delta HU, with an average for the ownership of 11.8 stream crossings per mile. Although PALCO has an ongoing program for road maintenance and drainage modification on their property, most logging roads in the action area are susceptible to road crossing failure, particularly older roads built under different standards than are employed today. In addition, there is generally a lack of road surfacing. When heavy trucks drive on the road surface, gravel surfacing is ground into the road, and fine sediment from the underlying soil is forced to the surface. Thus, if road surfacing is not maintained, the road-generated sediment may approach pre-surfacing levels on roads with high traffic levels.

The road system in the action area is provided in Volume V, Map 8 in the Final EIS/EIR. Existing CFPRs require that during the wet season, only rocked roads may be used. Limited field reconnaissance has indicated that surfacing on some mainline roads is currently deteriorated from use within the action area.

Roads are one of the greatest sources of habitat degradation. Roads have significantly elevated on-site erosion and sediment delivery, disrupted subsurface flows essential to the maintenance of baseflows, and contributed to increased peakflows. Roads within riparian zones have resulted in reduced shading and disrupted the input LWD for the life of the road. These effects have caused a degradation of salmonid habitat by increasing fine sediment levels, reducing pool volumes, increasing channel width, exacerbating seasonal temperature extremes, and contributed to the lack of LWD.

Mass Wasting and Other Erosional Processes

Mass wasting is part of a watershed's natural disturbance regime and is sometimes beneficial to salmonids, providing coarse sediment and LWD into stream systems (Reeves et al. 1995). Nonetheless, increases in mass wasting events above natural levels are not beneficial for salmonids. Tectonic activity, erodible soils and naturally unstable parent material, high precipitation, and steep slopes characterize much of the landscape along the California Coast. This combination leads to a landscape dominated by mass movement processes (Chatwin et al. 1994) and high levels of sediment in streams. It is indicative of a landscape that is abnormally sensitive to destabilization by management activities. Streams in the Coast Range of northern California, for example, annually export 7,422.9 tons of sediment per square mile, compared to 151.3 to 291.1 tons of sediment per square mile in Oregon's Coast Range (Hawkins et al. 1983). Mass failures are a major source of sediment into streams. In the Redwood Creek basin, approximately 80 percent of the landslides occur on slopes of 50 percent gradient or more (Harden et al. 1995). In sediment-poor streams, mass wasting may bring in needed rubble and LWD (Everest and Meehan 1981), but sediment impoverishment is not a significant issue in managed basins of northwest California. Usually, mass movements bring sediment into higher-gradient channels, and the sediment is then carried downstream into deposition zones, potentially impairing rearing and spawning functions (Chamberlin et al. 1991). Depending on the amount of material transported, the velocity, and the channel gradient, mass failures that deliver sediment to streams can increase sediment loads, partially or completely block channels, scour streambeds, creating significant cumulative impacts downstream (Swanston 1991).

Mass movement frequency has been strongly linked to the type and intensity of land management within watersheds (Chamberlin et al. 1991, Harden et al. 1995, Rood 1984). In Redwood Creek, the number of streamside landslides increased from 100 in 1947 to 415 in 1976, due mostly to debris sliding following periods of intensive timber harvest, road construction, and large storms (Harden et al. 1995). Timber management activities that undercut hillslopes, increase surface weight, alter surface and subsurface flows, and reduce root strength strongly influence slope and soil stability (Chatwin et al. 1994). In some areas, management-related mass wasting events are primarily associated with roads and their drainage systems, while in other areas landslides are common on open slopes after logging activities (O'Loughlin 1972, Pacific Watershed Associates 1998). Impacts to salmonids may occur if mass failures caused by timber management activities deliver sediment to salmonid habitat or block or impair migration.

Erosion in the Coast range province of Northern California is dominated by mass movement processes. Mass movement is translocation of material by the force of gravity as opposed to movement of material by water. Six categories of landslides are identified and discussed in the Final EIS/EIR: deep-seated landslides (including earthflows and translational-rotational slides), and shallow, rapid mass wasting (including geomorphic features designated as inner gorges, debris slide slope/amphitheaters, debris slides, and debris flows. Each have different characteristics, modes of failure, and management prescriptions. Since the base of many earthflows is at a stream, the overall movement of an earthflow can generate large amounts of sediment through debris slides into streams. For example, Kelsey (1978) estimated that earthflows contributed 63,600 tons/mi^2 of sediment from 1941 to 1975 in a portion of the Upper Van Duzen watershed. This equates to approximately 3.9 feet of surface lowering per century, undoubtedly one of the highest denudation rates on the continent. Movement can be triggered by seasonal moisture accumulation in the soil, which increases pore water pressure and decreases the strength (effective stress) of the soil. While loss of root strength due to timber harvest probably does not affect deep-seated landslides, the increase in soil moisture caused by the decrease in evapotranspiration could cause increased movements (Bedrossian 1983). Effects are likely to be highly specific to each landslide.

Loss of Large Woody Debris

Past and present timber harvest practices have eliminated large trees, large logs, and other woody debris from streamside areas within the action area which could have otherwise been recruited to the channel. This is particularly a concern for California redwoods, which take many decades to decay and could have provided long term benefits to fish habitat and watershed stability. From the 1950s through the 1970s, forest management practices often included removal of LWD from streams based on the belief that it was detrimental to salmon migration. This resulted in major changes in the amount of cover habitat available and often changed stream habitats to a single, cobble-bed channel lacking pools and LWD or to bedrock channels lacking gravel, woody debris, and other channel features (Murphy 1995). This decrease in LWD corresponds to a reduction in salmonid use (House and Boehne 1987). Due to the time required for streamside trees to grow and mature to potential LWD, there may be a considerable lag period (e.g., greater than about 50 years and up to 300 years) before additional LWD is contributed to a cleared stream (Gregory and Bisson 1997). Stream clearing with accompanying replacement of structures (e.g., wood and large rocks) continued into the 1990s in the action area.

LWD from coniferous trees is an important component of freshwater salmonid habitat. It is provided to stream systems from hillslope processes such as debris torrents (McGarry 1994), but predominantly from adjacent and upstream riparian vegetation. Woody debris regulates sediment and flow routing, influences stream channel bedform and bank stability, and provides hydraulic refugia and cover within stream systems (Bilby 1984, Gregory et al. 1987, Hogan 1987, Keller and Swanson 1979, Keller et al. 1995, Lisle 1983, Nakamura and Swanson 1993, Sedell and Beschta 1991), thus influencing the formation of the spatial template within with salmonids exist (Sullivan et al. 1987, Vannote et al. 1980). This template includes pool-riffle bedforms, backwater and edgewater habitats, and cover that provide adult spawning and holding habitat, juvenile summer and overwintering habitat, and refuge habitat from high velocities and predation (Bisson et al. 1992, Sullivan et al. 1987). Reduction in the quantity or quality of any of these habitats may result in reduced survival of salmonids during the life history stages in which those habitats are used (Bisson et al. 1992, Hicks et al. 1991, Rhodes et al. 1994).

Juvenile salmonid abundance is often directly related to the amount of LWD in a stream (Murphy et al. 1986). Woody debris also plays a key role in the retention of salmon carcasses (Cedarholm and Peterson 1985), a major source of nitrogen and carbon in stream ecosystems (Bilby et al. 1996). Forest management activities within the aquatic protection zone have the potential to change the distribution, size, and abundance of LWD in streams (Hicks et al. 1991; Ralph et al. 1994) and to simplify stream channels (Bisson et al. 1992).

Large accumulations of LWD in streams in the form of logging slash, however, may be undesirable and may block fish passage in extreme cases. Logging slash may include larger tree branches and short sections of wood without rootwads. Much of this type of LWD floats and, therefore, can be unstable (Bryant 1980). Unstable accumulations of LWD can wash out and destablize streambanks, potentially causing reductions in fish habitat and overall stream productivity.

CDFG has collected limited information on LWD during its stream habitat surveys in the WAAs of the action area. These data, which are summarized in R2 (1997), provide values for LWD on PALCO lands ranging from less than 1 piece of LWD per 100 feet of stream (e.g., some streams in the Eel River drainage) to over 15 pieces per 100 feet (e.g., portions of the South Fork of Freshwater Creek).

Loss of Riparian Vegetation and Function

As described previously, vegetation within the riparian zone greatly influences the biological and physical processes that provide freshwater habitat for salmonids. These ecosystem roles include maintenance of shade and cover, water quality and flow routing, the aquatic food web, sediment routing and composition, stream channel bedform and stability, and linkages to floodplain (Beschta 1991, Gregory et al. 1991, Naiman et al. 1992, Schlosser 1991, Sullivan et al. 1987). Riparian vegetation produces habitat for salmonids, and its roles vary with the position of the stream reach in the fluvial network (Vannote et al. 1980).

An important product of riparian vegetation is shade, which moderates water temperatures. Reduced shade leads to increased water temperatures, which reduces the success or survival of salmonids during adult upstream migration, juvenile rearing, and downstream migration of smolts. Increased water temperatures have also obstructed adult migration and limited spawning success, triggered early juvenile outmigration resulting in decreased survival rates (Beschta et al. 1987), changed juvenile sheltering behavior (Taylor 1988), reduced disease resistance, and increased metabolic requirements (Beschta et al. 1987).

Timber harvest practices occurring upstream of salmonid habitat may also adversely affect salmonids. Perennial reaches upstream of salmonid habitat influence instream temperatures in larger reaches downstream. The loss of shade from riparian vegetation above salmonid habitat may increase instream temperatures downstream. Upstream reaches, including intermittent and emphemeral streams, carry sediment, nutrients, and woody debris from upper portions of the watershed down to salmonid habitat. The quality of salmonid habitat is determined, in part, by the timing, speed, and amount of organic and inorganic materials transported downstream from reaches above salmonid habitat (Chamberlin et al. 1991). Management activities that increase sediment inputs upstream of salmonid habitat may impair important habitat components, such as deep pools and clean spawning gravels, in downstream reaches. Woody debris in upstream reaches meters sediment and organic debris inputs downstream; the loss of LWD in these upstream reaches may increase the efficiency of sediment and debris transport into salmonid habitat. A paucity of LWD in these upstream reaches also means less LWD available for movement downstream into salmonid habitat.

Forestry practices have affected and have the continued potential to affect freshwater habitat for salmonids through changes in the characteristics of, and inputs from, streamside vegetation (Gregory et al. 1987, Ralph et al. 1994). The NMFS believes that within riparian areas, forest management activities within, adjacent to, or above streams containing salmonid habitat may cause changes in stream temperatures, increase sediment levels, alter species composition and abundance of macroinvertebrates, destabilize streambanks and streamside areas, reduce in-stream structural complexity, reduce LWD recruitment, and alter peak and base flows. Furthermore, the presence and use of roads within this area may contaminate water, create barriers to migration, reduce stream shading, reduce large wood recruitment to the stream, and increase sediment levels. All of these impacts to habitat may harm salmonids.

The current riparian habitat conditions in the action area have been shaped by over 100 years of timber harvest, as well as recent floods, such as the 1964 floods, which reshaped most of the stream channels in the Humboldt area. It is well documented that a considerable portion of riparian ecosystem has been altered or lost since the mid-1850s. Logging on both public and private lands has left a legacy of altered habitats that still require considerable time for recovery, and the return to historical conditions will probably never occur on a large proportion of the forest landscape. Timber harvest practices were not regulated in riparian zones until the 1970s; thus there were more than 120 years of human activity and 50 to 70 years of intensive harvest before mandated consideration of streamside protections. Forest practices which contributed to the decline of riparian habitat include timber harvest to streambank; railroad and road building along the riparian corridors; and splash damming. Additionally, removal of LWD was a biologically recommended practice until the mid-1970s. All of these practices led to a considerable reduction in riparian zone function within the action area.

Loss of Habitat Complexity and Connectivity

Loss of habitat complexity has also contributed to the decline salmonids and suitable habitats. For example, in national forests in Washington, there has been a 58 percent reduction in large, deep pools due to sedimentation and loss of pool-forming structures, such as boulders and large wood (USDA Forest Service et al. 1993). Similarly, in Oregon, the abundance of large, deep pools on private coastal lands has decreased by as much as 80 percent (USDA Forest Service et al. 1993). Sedimentation from land-use activities is recognized as a primary cause of habitat degradation. Site-specific information about habitat complexity and connectivity is not available for PALCO lands.

Changes in Stream Flows and Hydrology

Streamflows and hydrology in northern California have been altered by timber harvest activities. Timber harvest has altered normal streamflow patterns, particularly the volume of peak flows (maximum volume of water in the stream) and base flows (the volume of water in the stream representing the groundwater contribution). The degree these parameters have changed and the area affected depends on the percentage of total tree cover removed from the watershed and the amount of soil disturbance caused by the harvest, among other things. For example, when harvest activities remove a high percentage of tree cover and cause light soil disturbance and compaction, rain falling on the soil infiltrates normally. However, due to the loss of tree cover, evapotranspiration (the loss of water by plants to the atmosphere) is generally much lower than before. Thus, the combination of normal water infiltration into the soil and greatly decreased uptake and loss of water by the tree cover results in substantially higher, sustained streamflows. Hence, this type of harvest has resulted in higher base flows during dry times of the year because infiltration has not decreased and evapotranspiration is low. On the other hand, when the harvest activities caused high soil disturbance and compaction, little rainfall penetrates the soil and recharge groundwater. This has resulted in higher surface runoff and equal or slightly higher base flows during dry times of the year. During wet times of the year, the compacted soils deliver high amounts of surface runoff, substantially increasing peak flows. In general, timber harvest on a watershed-wide scale has resulted in water moving more quickly through the watershed (i.e., higher runoff rates, higher peak and base flows) because of decreased soil infiltration and evapotranspiration. This greatly simplified model only partly illustrates the complex hydrologic response to timber harvest (Chamberlain et al. 1991, Gordon et al. 1992).

Watershed Degradation

Watershed-level variables, such as the drainage network, presence of roads and disturbance history all have affected salmonid habitat. The cumulative effects of numerous roads and other disturbances within watersheds has increased sediment levels, altered hydrology, changed the drainage network, and altered the timing and magnitude of flows. Watershed conditions are additive, that is individual impacts that are perhaps by themselves relatively minor at a watershed scale have been damaging when combined with the impact from one or more other impacts that have occurred with the watershed (Spence et al. 1996). Five watersheds, Bear, Jordon, Stitz and Freshwater Creeks, and Elk River are listed by CDF as being cumulatively impaired due to sediment problems resulting from past forestry activities.

Forest Chemicals and Nutrients

Chemicals used in forest management activities, including pesticides, herbicides, insecticides, fertilizers, fire retardants, petroleum products, and heavy metals can enter streams directly or be carried by runoff water. All of these chemicals can affect salmonids by their direct toxicity or by altering primary and secondary production and influencing the amount and type of food available (Norris et al. 1991). When chemicals are transported across or adjacent to streams, a chemical-spill hazard exists (Furniss et al. 1991). Chemicals may also indirectly impact salmonids through habitat alteration (e.g., changes in riparian plant community). Even at sublethal levels, chemicals may alter neurological, endocrine, and behavioral functions in fish (reviewed in Spence et al.

1996). Excess nitrogen, phosphorous, and other nutrients can enrich surface waters. Enrichment can lead to high phytoplankton and benthic invertebrate production. Too much enrichment can cause algal blooms, which may lead to oxygen depletion in the water. For healthy aquatic habitat, watersheds should have low levels of chemical contamination from agricultural, industrial and other sources and be in compliance with the North Coast Water Quality Basin Plan (NCRWQCB 1996).

The aerial application of fire retardants on or near streams can alter water chemistry and impact salmonids. Norris et al. (1991) summarize the results of an earlier study which showed that direct application of fire retardants to aquatic systems temporarily increased levels of ammonia, nitrogen, and phosphorus to potentially lethal levels. They also noted that some commercial fire retardants contain ferrocyanide as a corrosion inhibitor. The ferrocyanide decomposes under sunlight, then reacts with water to form highly toxic cyanic acid (HCN).

Wildfires also directly affect water quality by destroying vegetative cover and altering the physical properties of surface soil. Fire exposes bare mineral soil to increased surface erosion and runoff. Increases in landslide potential can also occur up to five years after a wildfire event due to the decay of root systems (Swanston 1974 cited in Swanston 1991). Wildfire events can also result in increased inputs of wood and other debris into streams, elevated streamflows, heightened stream temperatures, and increased nutrient levels. Young (1994) noted increased debris transport following wildfires as a result of increased flows and decreased bank stability. Suppression activities associated with wildfires can also impact aquatic and riparian resources through the application of fire retardants, and the construction of fire lines, base camps, and staging areas.

PALCO began large-scale use of herbicides in 1994 as part of a shift towards intensive forest management. PALCO currently uses only EPA "unrestricted herbicides" Oust, Atrazine, Roundup, Accord, Garlon 3A, and Garlon 4 (SYP/HCP). PALCO's existing use of herbicides is subject to all applicable federal and state laws and presently does not employ aerial applications.

At present PALCO is currently engaged in a multi-year reforestation program, reclaiming hardwood areas from older unmanaged clearcut harvests. Herbicides are used as part of this reforestation effort. The current rate of reforestation is 2,000 acres per year and is expected to continue at that rate for another ten years. The reforestation area plus ongoing clearcut harvest amounted to approximately 4,850 acres in 1997. Similar activities were underway in 1998, with the substitution of Oust for most of the Aatrex application in an effort to reduce groundwater contamination.

Current water quality monitoring has not shown measurable levels of herbicides near any of PALCO's ground-based applications, but present monitoring data do not cover Class III ephemeral drainages or some of the streamside environments so effects due to baseline conditions are uncertain.

Grazing

In general, livestock grazing has deteriorated significant areas of the western States. Since the 1930s, rangelands in the Pacific Northwest have benefitted from less intensive grazing; however, the majority of western rangelands are in deteriorated conditions (Spence et al. 1996). Poor upland conditions may increase sediment loads to streams and alter hydrologic regimes, leading to channel incision, channel widening, and further deterioration of riparian zones. Hydrologic changes may occur in response to loss of vegetation or change in soil permeability brought on by reduced organic content, splash erosion, and trampling by livestock. Similarly, sediment transport processes are linked to vegetation cover and the routing of water from the hillslope to the stream (Spence et al. 1996). Since livestock tend to concentrate in areas near water, shade, preferred vegetation, salt and a relatively level topography, essential riparian areas for salmonids may be heavily utilized and become over grazed and trampled, leading to erosion and hydrologic disruptions.

Cattle and sheep grazing has occurred within the action area since the early 1900s. In the 1920s PALCO was actively converting forested land into pastures. Approximately 1,000 head of cattle and sheep were grazed on 15,000 to 25,000 acres of logged and open land. Presently, about 5,700 acres is leased to private cattle operations and about 600 head of cattle graze on PALCO's ownership. This number has decreased from a historical use of 2,000 to 3,000 head of livestock. PALCO has estimated that approximately 6 to 10 acres of pasture land is needed per animal unit across all of PALCO's leased properties. At present, 15 different areas are leased for grazing with 1.3 to 18 acres per animal unit month across PALCO's ownership, averaging 10 acres per unit. According to PALCO (1998), most of these areas have exclusion measures or have inherent site features that limit livestock access to riparian streams. The extent of grazing and effects on salmonid habitat in the action area are currently unknown.

Gravel mining

Sand and gravel mining in riparian areas may have substantial effects of stream channels and hydraulic characteristics of areas essential for salmonids. In addition to the immediate morphological changes in stream channels caused by excavation, channels continue to exhibit instability, accelerated erosion, and altered substrate composition and structure after erosion has ceased (Spence et al. 1996). The associated downcutting of stream channels which frequently follows gravel mining may involve 13.1 to 19.7 feet of depth, resulting in increased flood peaks, increased sediment transport, increased temperatures, and decreased base flows. The most direct impact to salmonids are degradation and simplification of spawning and rearing habitats and increased turbidity (Spence et al. 1996).

Existing gravel and rock extraction activities in the action area include near-stream gravel mining, borrow pits, and rock quarrying. Near-stream gravel mining includes surface-mining operations (paddle wheel skimming from river bars) on the Eel River above the Van Duzen River. Eleven gravel operations are currently located along an eight mile stretch of the lower Eel River, and two additional operations are located on the lower reaches of the Van Duzen River. These gravel operations are under the jurisdiction of Humboldt County, the California Coastal Commission (for those activities conducted within the Coastal Zone) and the COE. Gravel operations are conducted under a Letter of Permission (LOP) adopted by the COE for all navigable waters of the United States within Humboldt County. Under the LOP, the number of operators, location of gravel operations, and amount of material removed varies from year to year, based on annual cross-section surveys and other information, as determined by the County of Humboldt Extraction Review Team (CHERT). The annual maximum amount of gravel permitted to be to extracted by the 13 gravel operations in this area is estimated by CHERT to be approximately 1,480,000 cubic yards. Actual extraction is generally much lower (e.g., less than 400,000 cubic yards in 1995) (California Coastal Commission 1998). Take of SONCC coho salmon is permitted under an Incidental Take Statement issued to the COE on July 9, 1997 for activities involving the near-stream gravel mining. The Incidental Take Statement expires five years from issuance.

Utilization

Commercial, Recreational, and Tribal Harvest

Coho salmon from the action area are contacted by ocean fisheries primarily off California. Coded-wire tagged coho released from hatcheries south of Cape Blanco have a southerly recovery pattern; primarily in California (65-92 percent), with some recoveries in Oregon (7-34 percent) and almost none (1 percent) in Washington or British Columbia (percent data represent range of recoveries for five hatcheries by state or province) (Weitkamp et al. 1995). Ocean exploitation rates for SONCC coho are based on the exploitation rate on Rogue/Klamath hatchery stocks and have only recently become available. The estimated ocean exploitation rates were 5 percent in 1996 and 1997 and 12 percent in 1998 (Pacific Fisheries Management Council 1997, 1998). The extent to which coded-wire tagged recovery patterns of these hatchery stocks coincide with the distribution patterns of wild coho is not known.

Steelhead are not generally caught by commercial or recreational anglers in the ocean. However, although little documented evidence exists, high seas driftnet fishing has been implicated as a cause for decline of steelhead from coastal streams along the North American Pacific Coast (Light et al. 1988). Based on recoveries of marked and tagged North American steelhead, high seas steelhead distribution and driftnet fisheries overlap (Light et al. 1988, Burgner et al. 1992) and recent declines in steelhead abundance may be partially attributed to the harvest of steelhead in high seas driftnet fisheries (reviewed in NMFS 1996). Relatively recent observations of returning steelhead to Rowdy Creek Fish Hatchery on the Smith River in 1992 (just north of the action area) showed healed gillnet scars on 30 of 155 adults (Higgins et al. 1992).

The authorized high seas driftnet and squid fisheries which are thought to have significantly contributed to the decline of listed salmonids have been severely restricted, although unauthorized fisheries are likely to continue at reduced levels.

Sport and commercial fishing restrictions ranging from severe curtailment to complete closures in recent years may be providing an increase in numbers of adult coho spawners in some streams, but trends cannot be established from the existing data. California State fishing regulations prohibit retention of coho in all marine and freshwater fisheries. Some incidental coho mortality likely occurs in association with the release of coho in chinook directed freshwater fisheries but that level take is believed to be low.

Historic estimates of harvest in California's rivers by sport anglers are based on limited monitoring. In the early 1960s, there was an estimated harvest of 122,000 adult steelhead per year and an unknown quantity of harvested juvenile steelhead (CDFG 1965). Harvest rate estimates for the Klamath River for the 1977-78 through the 1982-83 seasons ranged from 7.4 percent to 19.2 percent and averaged 12.1 percent. Preliminary estimates for 1993 show that an estimated 40,500 steelhead were harvested state-wide in California, with 71 percent of the effort occurring along the northern California coast, primarily in the Smith, Klamath, Trinity, and Mad Rivers (T. Jackson, pers. comm., cited in NMFS 1996). Sport fishing catch rates are presently at low levels in the state, indicating declining steelhead population numbers, irrespective of reliable steelhead population estimates (McEwan and Jackson 1996) Illegal harvest can be a serious problem for salmonids on their spawning beds and on their summer rearing/holding habitats. Roelofs (1983) cited poaching as a serious problem on summer steelhead in northern California streams. Large numbers of spring run chinook salmon and summer steelhead seek deep pools as resting or holding sites during periods of sustained flow (e.g., summer steelhead may spend several months in freshwater before spawning). They seek the cover provided by the deep pools and the potentially cooler water temperatures that may be found in these pools during the summer (Nielson et al. 1994, Moyle et al. 1995). During this holding period, the fish are conspicuous, congregate in the pools, and are often unable to leave the pools due to low stream flows. Moyle et al. (1995) has indicated that one of the most immediate threats to adult summer steelhead (and likely other salmonids that may rest in these deep pools) is poaching. Both snagging of fish from the bank and spearing by divers have been reported. Rivers considered to have a serious poaching problem within the action area include the Middle Fork Eel river and Redwood Creek.

Brown et al. (1994) estimated that approximately 90 percent of the Klamath-Trinity basin coho salmon are of hatchery origin. The average annual tribal harvest of coho salmon over the past 5 years has been 670 fish (NMFS 1997), of which 70 may have been naturally spawning. If the minimum population of naturally spawning SONCC coho is about 10,000 fish (Weitkamp et al. 1995), the Tribal impact on listed SONCC coho salmon has been relatively small, on average less than 100 fish per year during the past 5 years and less than 1 percent of the SONCC ESU. Maximum tribal harvest rates on Klamath Basin coho salmon averaged 5 percent from 1992-1997. Tribal harvest rates for chinook salmon on the Eel River and elsewhere within the SOCC chinook salmon ESU are similar. There are no tribal fisheries on coho populations in the Rogue, Smith, Eel or Mattole rivers.

In California, steelhead are taken during the Yurok tribe's fall chinook salmon subsistence fishery in the Klamath river. From 1984 through 1992, an estimated 2,350 steelhead were captured, with a range of 472 in 1984 to 68 in 1992, and an estimated mean of 260 steelhead per year (Craig and Fletcher, 1994). No data is available on the Hoopa or Klamath tribes net fisheries in the Klamath Basin.

Scientific Utilization
Section 10 (a)(1)(A) of the Act authorizes NMFS to issue permits for scientific purposes or to enhance the propagation or survival of listed species. The permitted activity must not operate to the disadvantage of the species and must be consistent with the purposes and policy set forth in section 2 of the Act. The direct and indirect take considered in previous NMFS biological opinions for scientific research permits are considered part of the environmental baseline. Since the SONCC coho salmon ESU was listed, NMFS has completed one programmatic consultation on the issuance of section 10 (a)(1)(A) permits. As of the date of this Opinion, 25 permittees have been covered under the programmatic scientific permit consultation. Under this consultation, take, in the form of kill, harm, and harassment has been authorized for of 265,145 coho salmon adults, juveniles, and adult carcasses. The majority of this take (approximately 98 percent) is in the form of observation or capture and release, and has a minor or moderate effect. Authorization of limited lethal take has been issued for research-associated accidental mortality and direct sampling for eight adults, 2,547 juveniles, and 600 adult carcasses. Effects considered in the issuance of the scientific permits were for the most part, non-lethal in nature and have involved mainly take by harassment (i.e., observation and/or capture/handle/ release actions). The NMFS concluded that the effect of the take authorized by issuance of this scientific permit would not appreciably reduce the survival and recovery of the SONCC ESU coho salmon in the wild.

Disease or Predation
Infectious diseases constitute one of the many factors that can influence adult and juvenile survival in salmonids. Salmonids are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment. Specific diseases, such as bacterial kidney disease, ceratomyxosis, columnaris, furunculosis, infectious hematopoietic necrosis virus, redmouth and black spot disease, erythrocytic inclusion body syndrome, and whirling disease, among others are present and are know to affect salmonids (63 FR 13347). Very little current or historical information currently exists on the occurrence of these diseases in salmonids considered in this Opinion, much less within the action area. Studies have shown, however, that naturally spawned fish tend to be less susceptible to pathogens than hatchery-reared fish (Buchanon et al. 1983, Sanders et al. 1992).

Introductions of non-native species and habitat modifications have resulted in increased predator populations in numerous river systems, thereby increasing the level of predation experienced by salmonids. A high abundance of non-native Sacramento squawfish has been reported recently in the Eel River Basin (Brown and Moyle 1991, Moyle and Yoshiyama 1992), suggesting increased risks of predation.

Predation by marine mammals is also of concern in some areas. NMFS has recently published a report describing the impacts of California sea lions and Pacific harbor seals upon salmonids and on the coastal ecosystems of Washington, Oregon, and California (NMFS 1997). This report concluded that in certain cases where pinniped populations co-occur with depressed salmonid populations, salmon populations may experience severe impacts due to predation. Pinniped predation on small populations of salmonids may be a concern in areas of restricted fish passage, such as the mouth of rivers or below dams. Predation by pinnipeds was identified as a threat in the final rule listing the coho salmon SONCC ESU and the proposed rule for the chinook salmon SOCC ESU, but NMFS concluded in both rules that the threat is minor, overall.

Hatcheries
The impact of hatcheries on the Pacific salmonids has been extensive. Because Pacific salmon have a moderately high fecundity (typically several thousand eggs per female) and a high natural mortality through the early life-history stages, successful fish hatcheries can generally produce many more juveniles than are produced in the wild. Increased juvenile production may (but does not always) result in increased returns of adult fish. However, the efficacy of artificial propagation as a tool for conserving natural salmon populations has not been clearly demonstrated. In fact, the success of artificial propagation for supplementation (i.e., the use of hatchery fish to increase the abundance of naturally spawning fish), is highly controversial (Miller et al. 1990, Steward and Bjornn 1990, Cuenco 1991). Past management practices have resulted in widespread propagation and transplantation of non-local stocks of these fish (Mathews 1980; Washington 1985; Lichatowich and McIntyre 1987), and the impacts of these practices are largely unknown. Although artificial propagation may contribute to the conservation of declining and listed populations, it is unclear whether or how much artificial propagation during the recovery process will compromise the distinctiveness of natural populations. Also unclear is whether or how much ongoing hatchery programs for unlisted species will affect the recovery of listed species or the viability of other unlisted species.

The Mattole Restoration Council (1992) reports that 250,000 salmonids were released in the Mattole watershed between 1980 and 1990. The council's experience with chinook and coho salmon is informative since they were released into tributary streams where chinook or coho salmon were previously extirpated and they now occupy these streams once again. For example, from 1986 to 1991 there have been coho salmon reported in the Lower Mill Creek, where they were previously extirpated. Coho salmon have also re-occupied the North Fork of Honeydew Creek from 1989 to 1991. The population is thought to be self-sustaining in Lower Mill Creek, but introductions continue in Honeydew Creek, Squaw Creek, Thompson Creek, Bear Creek, and the mainstem of the Mattole River.

Within the action area, and in connection with existing programs, PALCO has conducted surveys for certain federal- and state-listed species. PALCO currently operates a fish-rearing facility within the action area at its Yager Logging Camp and at Scotia. There are also two acclimatization tanks at remote sites in the Yager Creek basin. The facilities are used to capture, raise, and release the young of wild anadromous fish from Yager Creek basin. PALCO's fish rearing facilities are presently not covered by section 10(a)(1)(A) of the Act. Only non-listed species are currently being raised in these facilities.

Hydropower Development
Hydropower development has impacted listed salmonids in a variety of ways which have led to the existing conditions under the environmental baseline. Range-wide, construction of dams has

blocked access to miles of previously productive habitats. Modification of natural flow regimes has resulted in increased water temperatures, changes in fish community structure, and increased travel time by migrating adult and juvenile salmonids. Sublethal effects (e.g., stress, injury, descaling, and delay) can also occur and affect survival (Hawkes et al. 1991, Johnson et al. 1990). Physical features of dams such as turbines, have resulted in increased mortality of adults and juvenile salmonids as well and attempts to mitigate adverse impacts of these structures have to date met with limited success (NMFS 1986). In California, most hydroelectic development projects have not been required to construct fish bypass facilities; further, projects that have been required to provide fish passage have met with limited success. Dams within the range of the SONCC ESU, such as Copco Dam on the Klamath River, and Scott Dam and Cape Horn Dam on the Eel River, have eliminated or severely hindered access to historical spawning and rearing habitats and have altered the natural flow regimes within the basins. No estimates are available for salmonid mortalities associated with dams in California, however, it has been estimated that adult upstream passage mortalities may range from 5 to 10 percent loss per hydroelectric project in the Columbia and Snake Rivers results in 3 to 5 percent mortality (Kaczynski and Palmisano 1993). These estimates include mortalities which may result from delayed mortalities or possibly poaching. Additional mortalities occur due to "fall back" of migrating adults through turbine structures. Research in the Pacific Northwest has indicated that mortality rates for steelhead that fall back through turbines may range from 22 to 41 percent (Wagner and Ingram 1973).

The salmonid species considered in this Opinion tend to experience different types of direct and indirect physical impacts as a result of existing dam configuration and operations under the environmental baseline. These effects are discussed in NMFS (1996).

Water Diversions

In California, water withdrawals, conveyance and diversion has resulted in the loss of a significant amount of suitable salmonid habitat. Diversion and transfer of water has resulted in depleted river flows necessary for migration, spawning, rearing, flushing of sediment from the spawning gravels, gravel recruitment and transport of large woody debris (Botkin et al. 1995, California Advisory Committee on Salmon and Steelhead Trout 1988, Reynolds et al. 1993). These effects have contributed to the decline of the species considered in this Opinion rangewide and in the action area.

On the Eel River, upstream of the action area, as part of the Potter Valley Project, Pacific Gas and Electric Company (PG&E) currently diverts up to 100 percent of the flow at Cape Horn Dam. This water is exported to the Russian River system. Except for some minor accretion below the project, during summer months, the Eel River is dewatered between Cape Horn Dam and Outlet Creek. The relative contribution of Project water to flow in the Eel River is 61 percent at the confluence with Outlet Creek and seven percent at the ocean, but the relative contribution of water from the Project to at the action area is unknown.

On the Mad River, the Humboldt Bay Municipal Water district operates two surface diversions to supply water to pulp mills. Flows in the Mad River are regulated at Ruth Reservoir in order to provide adequate water for these diversions. The maximum allocation from these two diversions is 60 million gallons per day.

Outside of the action area, but within the range of SONCC coho salmon, the Bureau of Reclamation's Klamath Project diverts water for irrigation from the Klamath River upstream of Iron Gate Dam. Releases below Iron Gate Dam vary annually depending on water year type (e.g. drought or wet year). Since 1996, the annual maintenance regimes were modified to include consideration of downstream salmonid populations. The Bureau of Reclamation is currently consulting with NMFS and USFWS on impacts of the Klamath Project operations on listed species.

The Bureau of Reclamation also exports water to the Sacramento River from the Trinity River. Since 1964, up to 80 percent of the annual flow has been diverted out of the Trinity River. A 1992 Department of the Interior Secretarial Order required a minimum 340,000 acre feet annual allocation to remain in the Trinity River. The Bureau of Reclamation has not yet consulted with NMFS and USFWS on the effects of this water allocation on listed species.

Other Natural and Human-Caused Factors

Natural Events

A series of six large floods occurred within the action area from 1950 to 1975. In particular, the historic flood of December 1964 caused extensive landsliding and gullying, particularly on harvested land (Kelsey 1980, Janda 1978). The combination of unusually high flow events and large inputs of sediment of all sizes produced substantial changes in stream channels that persist in some areas. Channels aggraded up to 12 feet and widened as much as 100 percent (Hickey 1969, Kelsey 1980, Lisle 1981). Channel courses were changed and many became braided. As a result, riparian corridors were stripped, and large volumes of woody debris were introduced by landslides and eroding banks.

Riparian vegetation in widened channels became more isolated from streams in summer, resulting in increased stream temperatures. Since that flood, newly formed banks and riparian vegetation in some stream channels have remained vulnerable to erosion at high flows (Sullivan et al. 1987). The absence of large floods since 1975 and 1986 (depending on the WAA) has helped to stabilize channel conditions so that riparian stands are increasingly less vulnerable to high flows. Most small channels have recovered to the point where riparian trees are reestablished and new debris is accumulating. This riparian vegetation has assisted in the reconstruction of banks by trapping and stabilizing fine sediment. The more recent 1996 "New Years Day" flood was also considered significant by many and demonstrated the susceptibility of some drainages and riparian areas to catastrophic storm events.

Environmental changes in both marine and freshwater habitats can have important impacts on salmonid abundance. For example, a pattern of relatively high abundance in the mid-1980s followed by (often sharp) declines over the next decade occurred in steelhead populations from most geographic regions of the Pacific Northwest. This result was most plausibly explained by broad-scale changes in ocean productivity. Similarly, 6 to 8 years of drought in the late 1980s and early 1990s adversely affected many freshwater habitats throughout the region. These natural phenomena put increasing pressure on natural populations already stressed by anthropogenic factors, such as habitat degradation, blockage of migratory routes, and harvest (NMFS 1996).

Human-Caused Factors

Since the SONCC ESU was listed, the NMFS has issued over 65 incidental take statements on federal activities which may affect the threatened coho salmon and its habitats. These activities have involved a wide range of activities including forest and/or resource area-wide routine and non-routine road maintenance, hazard tree removal, watershed and instream restoration, special use permits (e.g., gravel mining, ingress/egress), timber sale programs (e.g., green tree, fuel reduction, thinning, regeneration, and salvage), water diversions, culvert repairs, and bank stabilization. While few of these activities occurred or will occur within the action area, several of these activities are ongoing and/or will occur contemporaneously with the proposed action, so their effects are part of the baseline conditions experienced by the SONCC ESU and the other salmonids. The effects of these activities include the incidental take of listed SONCC ESU coho salmon due to increased sedimentation to streams, diversion of flows, destruction of riparian vegetation, modification of channel geomorphology, and increases in water temperature. In most cases, the effects of these activities on SONCC salmon have not been quantified. The incidental take statements issued with these consultations have identified reasonable and prudent measures to minimize the effects of any incidental take of SONCC ESU coho salmon for each of these activities, and monitoring of the actions has occurred. Since the effects of these activities are expressed in habitat functions, the ongoing effects of these activities on proposed and candidate salmonids are likely to be similar to those identified for SONCC ESU coho salmon to the extent that their distributions overlap. The overall effects of these activities on the environmental baseline for the species considered in this Opinion is however, uncertain.

Although most of PALCO's lands are closed to the general public, some recreational use does occur. Employees are allowed to hunt on the property, and the lands are used for recreation by a boy scout camp, a church camp, an archery club, and other organized groups.

Campgrounds, boating, swimming, trail construction and use, and other recreational activities can affect fish and fish habitat. Streams, streambanks, riparian vegetation, and spawning redds can be disturbed wherever human use is concentrated. Campgrounds can impair water quality by elevating coliform bacteria and nutrients in streams. Construction of summer dams to create swimming holes causes turbidity, destroys and degrades habitat, and blocks migration of juveniles between summer habitats. Recreational boaters remove snags and debris from rivers to improve aesthetics and safety, affecting habitat structure. Hiking trails can have similar effects as roads on aquatic habitat, especially if they are not maintained.

Federal Land Management

A very small percentage of the land ownership in action area is comprised of federal lands that are primarily managed by the USFS, BLM, USFWS, and USDI National Park Service. All BLM and

USFS lands in the action area currently receive timber harvest management prescriptions under the Northwest Forest Plan. One of the primary goals of the Northwest Forest Plan is to restore currently degraded habitats and maintain the ecological health of watersheds and aquatic ecosystems, including salmon habitat conservation (USDA Forest Service and USDI Bureau of Land Management 1994). The effectiveness of the Northwest Forest Plan in the action area is limited by several factors: 1) federal land ownership is not uniformly distributed in watersheds. For example, most of the federal lands are distributed at higher elevations and further inland (with the exception of Humboldt Redwoods State and National Parks) than private land ownerships, which tend to be at lower elevations and more coastal. Thus, existing protections provided for salmonids on federal lands under the environmental baseline are not sufficient to conserve listed species, and 2) in other areas, particularly BLM lands, federal lands are distributed in a checkerboard fashion, resulting in fragmented landscapes. These factors combined are currently limiting the ability of the Northwest Forest Plan to fully achieve its aquatic habitat restoration objectives at a watershed or river basin scale under the environmental baseline. Although these Federal lands within the action area are limited, NMFS has concluded that biological risks associated with habitat modifications and degradation on Federal lands have declined in this ESU due to implementation of the Northwest Forest Plan, coupled with the completion of numerous section 7 consultations.

<u>*Non-Federal Land Management*</u>

The CDF enforces the CFPRs on private and State managed forests. Northern California river basins (i.e, Redwood Creek, Mad River, Eel River, Mattole River, Bear River, Ten Mile River, Noyo River, Big River, Albion River, Navarro River, Garcia River, and Gualala River) are composed of private forest lands where timber harvest is managed by CDF. In these 11 river basins, private forest lands average about 75 percent of the total acreage, with a range of 42 percent (Eel River) to 94 percent (Gualala River). NMFS has reviewed the CFPRs to determine their adequacy for protecting anadromous salmonids in California (NMFS 1998). Specifically, the review determined that, although the CFPRs mandate protection of sensitive resource such as salmonids, the CFPR provisions and their implementation and enforcement, fall short of accomplishing this objective. Specific problems with the CFPRs identified by NMFS (1998) include 1) the inclusion of many protective provisions that are not supported by or with scientific literature; 2) provisions that are scientifically inadequate to protect salmonids; 3) inadequate and ineffective cumulative effects analysis; 4) dependency upon registered professional foresters who may not possess the necessary level of multi-disciplinary technical expertise to develop appropriate THPs that do not adversely affect salmonids; 5) dependency by CDF on other State agencies to review and comment on THPs for aquatic resource protection; 6) failure of CDF to incorporate recommendations from other agencies, and 7) inadequate enforcement due to staffing limitations. In 1997 CDF issued guidelines for the protection of listed coho salmon, *Coho Salmon Considerations for Timber Harvesting Under the California Forest Practice Rules* April 1997. Although these "coho considerations" are an improvement over CFPRs, they are only voluntary and therefore are not applied consistently. Even if applied fully and consistently throughout the SONCC coho ESU, the level of protection in the coho considerations, generally, is not adequate to avoid significant adverse effects to coho salmon or their habitat.

Habitat Enhancement

Several projects are currently underway to assess and restore stream habitat conditions for salmonids within the action area. The CDFG Fisheries Habitat Restoration Program plans and implements salmonid habitat restoration projects, or solicits proposals from outside of CDFG for development and implementation in cooperation with CDFG. Activities include placement of boulder clusters, root wads, wing-deflectors, digger logs, and spawning gravel, but could also involve slide stabilization, revegetation, culvert improvements, and installation of fishways. Activities implemented through this program must follow the California Salmonid Stream habitat Restoration Manual, Third Edition (Flossi et al. 1998). The effects of the CDFG Fisheries Habitat Restoration Program on listed salmonid species were analyzed in an August 6, 1998 biological opinion to the COE. Effects considered included temporary impacts from short-term increased levels of turbidity. The Incidental Take Statement permitted a minimal level of incidental take, but this level was determined to be unquantifiable. Habitat enhancement projects are generally considered beneficial to salmonids, but short-term effects can occur, usually in terms of increased turbidity during placement of new structures. Long-term adverse effects can also occur if enhancement activities are not properly planned and executed.

Some projects that have been completed or are currently under way within the action areal include: 1) Numerous stream enhancement/restoration projects undertaken by PALCO since 1987. These efforts have included access improvements, bank stabilization structures, and in-stream channel enhancements. About 50 projects are completed each year; 2) operation of a weir on Freshwater Creek and stream restoration activities conducted by the Humboldt Fish Action Committee; and 3) an extensive stream assessment and restoration activities in the Mattole River watershed conducted by the Mattole Watershed Salmon Support Group.

In the Mattole River, many sites along the 62-mile length of the river have been the subject of a well-focused restoration effort. Although the Mattole Restoration Council has not delineated specific ecological criteria for success, it is clear that restoration of self-perpetuating native salmonid populations continues to be a major goal. Quantitative data are lacking on the extent of watershed and bank treatment and returns of native fish.

PG&E's Potter Valley hydroelectric project is a major diverter of water from the mainstem Eel River. As the result of consultations with the FWS, NMFS, and CDFG, PG&E recently constructed a $14 million fish screen facility at the Cape Horn Dam diversion on the Eel River and will also increase project flows to the Eel River by an additional 15 percent. These additional instream flows combined with the new fish screening facilities are expected to improve habitat quality and benefit all salmonids in this system. As part of a proposal being carried forward to Federal Energy Regulatory Commission, PG&E is funding efforts to suppress Sacramento squawfish in the Eel River as well as other monitoring activities.

Several efforts are in the planning and/or implementation stage by federal, state, local, and tribal interests to promote the conservation of declining stocks of salmonids. Many of these efforts will directly and indirectly benefit the Pacific salmonids within the action area. Progress on these efforts, and estimates of timing for their implementation are summarized in NMFS (1996).

As part of the Salmon, Steelhead Trout, and Anadromous Fisheries Program, the CDFG has produced a draft plan which outlines management activities for the restoration and maintenance of California's steelhead populations. Further, in recognition of the need to protect the genetic integrity and habitats of all steelhead stocks, the CDFG Commission has recently updated and amended it's Steelhead Rainbow Trout policy. These, and other ongoing and future efforts to recover steelhead stocks are discussed in NMFS (1996).

Integration and Synthesis of the Environmental Baseline

The decline of Pacific salmonids is not the result of a single factor, and to search for the single cause is a misleading oversimplification. Multiple factors have contributed to the decline, and multiple factors may still be preventing recovery. The identification of one such factor does not rule out the possibility that others are also acting, perhaps synergistically, to prolong the decline. Furthermore, the causes for the decline appear to include both natural and anthropogenic influences.

- Coho salmon stocks in the northern California region of the SONCC ESU could be less than six percent of their abundance during the 1940s and have experienced at least a 70 percent decline in numbers since the 1960s. This decline prompted the NMFS to list the SONCC ESU as threatened. Likewise, populations of chinook salmon, steelhead, and coastal cutthroat trout have declined severely to levels that have warranted their consideration for listing

- Current riparian habitat conditions in the action area have been degraded and/or modified by over 100 years of timber harvest, as well as recent floods, such as the 1964 floods, which reshaped most of the stream channels in the action area. It is well documented that a considerable portion of riparian ecosystem has been altered or lost since the mid-1850s. Existing freshwater habitat conditions in the action area do not fully meet the essential habitat requirements of salmonids.

- Timber harvest activities have altered watershed conditions within much of the action area by changing the quantity and size distribution of sediment, leading to stream channel instability, pool filling by coarse sediment, or introduction of fine sediment to spawning gravels. These conditions have led to a reduction in the presence of suitable spawning areas within the action area. While current forestry management under the Northwest Forest Plan is considered to be generally protective of Pacific salmonids, timberland managed under this system makes up only a very small percentage of the action area. On non-federal timberlands, existing CFPRs fall short of providing adequate protections for salmonid habitats. Ongoing forest activities on non-federal lands are likely to continue to degrade essential salmonid habitat values.

- The ability of riparian ecosystems to control sediment inputs from surface erosion has been severely reduced in several areas within the action area due to timber harvest practices such as harvest to streambanks. The resulting loss of vegetation or organic litter (including LWD), combined with slope, soil type and drainage characteristics have reduced the ability of riparian buffers to trap sediments by determining the infiltration rate of water and the velocity of overland flow. These factors have combined to increase the delivery of fine sediments to several streams in the action area, significantly reducing the suitability of stream conditions for listed salmonids. Bear, Jordan, Stitz and Freshwater Creeks, and Elk River within the action area are currently listed by CDF as cumulatively impacted by sediment due to past forestry practices.

- Geomorphological characteristics of several WAAs proposed for harvest activities within the action area have high erosion hazard ratings, posing significant risks for mass wasting events following harvest activities, which could severely affect salmonids.

- Several watersheds within the action area have been identified as having sediment and/or water temperature problems. The EPA has listed the following river systems under the Clean Water Act section 303(d) as "water quality limited": Mad River (sediment and turbidity), Freshwater Creek (sediment), Elk River (sediment), Yager Creek (sediment), Eel River (sediment and temperature), Van Duzen River (sediment), Mattole River (sediment and temperature).

- Past and present timber harvest practices have eliminated large trees, large logs, and other woody debris from streamside areas within the action area which could have otherwise been recruited to the channel. Removal of LWD from streams on the belief that LWD was detrimental to salmon migration resulted in major changes in the amount of cover habitat available and often changed stream habitats to a single, cobble-bed channel lacking pools and LWD or to bedrock channels lacking gravel, woody debris, and other channel features (Murphy 1995). Due to the time required for streamside trees to grow and mature to potential LWD, there may be a considerable lag period (e.g., greater than about 50 years and up to 300 years) before additional LWD is contributed to a cleared stream (Gregory and Bisson 1997).

- Commercial, recreational, and tribal fisheries continue to incidentally take listed SONCC ESU coho salmon and proposed SOCC chinook salmon. Ocean harvest rates for coho remain at approximately 12 percent.

- Poor/uncertain hatchery practices in the past continue to have lingering adverse effects on natural populations of Pacific salmonids within the action area.

- Predation from non-native Sacramento squawfish in the Eel River basin remains uncontrolled. Marine mammal predation will continue.

- Gravel Mining activities continue to modify streambed structure and hydrologic flows.

- Grazing activities have degraded riparian areas within the action area and will continue.

- Ongoing federal activities which result in direct and indirect take (e.g. water diversions, culvert repairs) will occur contemporaneously within the range of the salmonids considered in this Opinion. Since much of the incidental take associated with these projects has been unquantifiable, the overall contribution of the effects of these actions to the environmental baseline is uncertain.

- Natural events (i.e., floods, earthquakes, fires) have caused significant modifications to habitats in the past and are likely to recur. The action area experiences frequent seismic activity.

In the face of all these changes and influencing factors, the SONCC coho salmon, SOCC chinook salmon, Northern California steelhead, and SOCC coastal cutthroat trout ESUs do not appear to be able to maintain themselves. The available evidence suggests that a significant part of the problem is lack of properly functioning habitat. Observations of salmonid abundances since the 1950s illustrate that severe declines of salmon have occurred.

LISTED SPECIES/CRITICAL HABITAT:

American peregrine falcon

Species

Numbers and distribution

Twenty-five peregrine nest sites (including 5 alternate sites) are known to occur within a subregional area that includes Humboldt, Del Norte and western Trinity counties. Annual monitoring of these sites has been incomplete, with some sites not being monitored for several recent years.

Three peregrine nest sites are known to occur in the action area; one of which is known to occur on PALCO lands. The three known sites in the action area represent 15 percent of the known sites (not counting alternate sites) in the three-county subregional area. The single known site on PALCO lands represents five percent of the known sites (not counting alternate sites) in the subregional area. The two sites not located on PALCO lands may be within 0.5 mile of PALCO lands. Actual distance has not been measured.

Reproduction
Productivity and occupancy of the sites in the 3-county area are incompletely known, due to lack of systematic and complete monitoring surveys. However, as many as 12 of these sites have been occupied during a single year based on limited monitoring.

Suitable habitat
Landscape comparison
Since peregrines use a wide variety of terrestrial habitats (including associated aquatic habitats) during their annual life cycle, no estimate of suitable foraging habitat is available for the species on a local (three county), regional, or range-wide basis. Similarly, no estimate exists of the number of potential nest cliffs and other ledge sites that might be available for peregrine nesting at any of these landscape scales. No landscape comparison of the amount of suitable habitat between the action area and any larger scales is available. However, the FWS has previously indicated that suitable habitat is not considered to be a limiting factor in the recovery of this species (USDI Fish and Wildlife 1998).

Factors affecting species and suitable habitat in the action area
Other completed or contemporaneous actions
At the present time, the FWS is involved in one consultation involving the potential take of peregrine falcons within the action area. During January and February, 1998, the North Coast Railroad Authority requested a permit from the COE to repair portions of the track that had slumped into the Eel River at Scotia Bluffs; the repair involved placement of riprap within the waters of the U.S. The COE issued a permit under Nationwide Permit 13 (bank stabilization) to cover the completed work. Consultation related to this project has not been completed to date; the COE is still attempting to secure the necessary information from the North Coast Railroad Authority. Since this project involved the use of equipment that creates noise in excess of ambient conditions, and is within 0.5 mile of a known nest site, the FWS anticipates that adverse effects to peregrine falcons may have occurred from this project. No suitable habitat was removed or degraded as part of this project, so adverse effects due to habitat loss are not expected to have occurred.

The FWS is also involved in a second consultation involving peregrine falcons along Highway 96 near Hoopa in Trinity County (within the three county subregional area, but not within the action area). Under emergency consultation authorization, Caltrans used explosives to remove a large boulder above the highway that was an immediate threat to human safety. This project occurred during the nest season and within 0.25 miles of a known peregrine nest site. Hence, the project may have resulted in adverse impacts to the species near the nest site. Caltrans has initiated formal consultation on this project; FWS has not completed the analysis or the biological opinion for this action.

Other protective measures
The peregrine falcon is currently protected as a bird of prey under section 3503.5 of the CDFG Code. This section of the code protects the species from the take, possession, or destruction of

nests or eggs. The species is also a "fully protected species" under section 3511 of the Fish and Game Code. Section 3511 prohibits the take or possession of this species or any part thereof. This code further prohibits the issuance of any permit or license issued for such take or possession, except as authorized by the commission for collection for scientific purposes, or for the live capture and relocation such species pursuant to a permit for the protection of livestock.

Northern spotted owl

Species

Numbers

A total of 156 northern spotted owl sites (122 pairs; 28 resident singles; 6 status unknown) occur on PALCO lands, based on surveys conducted during the period 1992 to 1998 (table 23; based on table 3.10-7 of the Final EIS/EIR. The stated number of pairs includes those identified as "Pair, Status Unknown" in table 3.10-7; "pair status unknown" was defined as a pair whose nesting status could not be determined but was included in the total number of pairs (S. Chinnici, pers. comm., Wildlife Biologist, PALCO, December 1, 1998). Pair and resident single owls on PALCO lands account for approximately 2 percent and 3 percent of the total number of pair and resident singles, respectively, throughout the owl's range. An additional 259 sites (221 pairs and 38 resident singles) are known to occur outside of PALCO lands and in the action area (source: CDFG Northern Spotted Owl Database). Most of the PALCO lands have been surveyed, however, the precise amount of area surveyed could not be quantified for the purpose of this consultation. The density of owl sites on PALCO lands (10 to 19 sites per township) is among the highest reported for the species (Gould 1995).

Distribution

Spotted owl sites are generally distributed throughout the action area, consistent with the distribution of suitable habitat. The distribution of known spotted owl sites is further described as follows, relative to key locations in the action area: MMCAs – 10 pairs and 2 resident singles; and Headwaters Forest – 5 pairs and 1 resident single.

Reproduction

During the survey period from 1992 to 1998, an average of 33.5 percent (range = 18.0 to 64.9 percent) of pairs detected were confirmed as nesting pairs on PALCO lands (Final EIS/EIR table 3.10-7). These nesting pairs produced an average of 27.2 total young per year (range = 11 to 40 young). An average of 1.2 young (range = 0.5 to 1.9 young) were produced per nesting pair (i.e., reproductive output). Data on productivity (i.e., number of fledged young per pair producing young) and on fecundity (i.e., female young fledged per female), as described by Franklin (1998a), could not be derived from the available information. All demographic data (e.g., survival rates) needed to calculate the growth rate or decline of the owl population on PALCO lands have not been collected.

Table 23. Comparison of number of owl sites and acres of suitable habitat found on PALCO lands, Humboldt County, California to those found at different landscape levels. Percentages shown represent the percentage of the total at each level that is attributed to PALCO lands. Data for PALCO lands are included in other landscape levels

	Owl numbers		Acres of
Landscape level	Pairs	Resident singles	suitable habitat
PALCO lands [1]	122	28	170,404
Action area [2]	343 (36%)	66 (42%)	771,782
Regional [3]	1,109 (11%)	238 (14%)	2,695,629
Recovery unit [4]	846 (14%)	171 (18%)	-[5]
Range wide [6]	3,602 (3%)	957 (3%)	8,300,000

[1] Owl numbers were based on Final EIS/EIR, table 3.10-7. Habitat data was based on PALCO (1999).

[2] Owl numbers were based on CDFG Northern Spotted Owl Database. Habitat data was based on The Resources Agency of California (1993).

[3] Owl numbers were based on the CDFG Northern Spotted Owl Database. Data for Curry County, Oregon was based on Oregon State Spotted Owl Database. Habitat data for Mendocino, Humboldt, and Del Norte counties was based on the Resources Agency of California (1993). Habitat data for Curry County, Oregon was only provided for two ownerships: Siskiyou National Forest (D. Lyke, pers. comm., January 22, 1999); and Coos Bay District of the BLM (J. Flora, pers. comm., January 11, 1999). As a result, the amount of suitable habitat in Curry County is underestimated. The estimate for the two ownerships, however, was overestimated because all canopy cover classes and size classes of predominately smaller diameter trees (generally not considered suitable habitat) were included in the total. The overestimate is greatest on the Siskiyou National Forest. The error in the estimate could not be determined for the purpose of this consultation.

[4] The recovery unit is defined as the California Coast Province (USDI Fish and Wildlife 1992a). Numbers of owls were based on the same source.

[5] "-" indicates data are not available.

[6] Owl numbers were based on USDA Forest Service and USDI Bureau of Land Management (1994). Habitat data were based on USDI Fish and Wildlife Service (1992a, Volume 1, page 37).

Suitable habitat

Landscape comparison

The PALCO lands encompass approximately 170,404 acres of suitable spotted owl habitat: nesting (94,543 acres); roosting (40,302 acres); and foraging (35,558 acres) (PALCO 1999). Nesting habitat is further described as follows: high quality (58,783 acres); moderate quality (35,223 acres); and low quality (537 acres). Foraging habitat in this context describes timber stands apparently suitable for use as foraging cover, and does not include early seral stages that may produce prey species.

The distribution of suitable spotted owl habitat is further described as follows, relative to key locations in the action area: MMCAs - 7,832 acres; and Headwaters Forest - 6,761 acres. Habitat quality in these area is further described as follows, based on PALCO (1999): MMCAs - high quality nesting (4,761 acres), moderate quality nesting (1,552 acres), low quality nesting (168 acres), roosting (524 acres), and foraging (826 acres); and Headwaters - high quality nesting

(4,606 acres), moderate quality nesting (1,157 acres), low quality nesting (91 acres), roosting (64 acres), and foraging (843 acres).

The amount of suitable habitat on PALCO lands is compared on a landscape level (table 23). Suitable spotted owl habitat on the PALCO lands comprise about 22 percent, 6 percent, and 2 percent of the total amount of suitable habitat in the action area, regional area, and rangewide, respectively.

The listed range of the northern spotted owl encompasses 54,360,500 acres, including all ownerships (USDI Fish and Wildlife Service 1992a). This estimate is based on province totals. PALCO lands occupy less than 0.4 percent of its total listed range.

Dispersal habitat
For the purpose of this consultation, all late-seral habitat (including uncut old-growth, residual old-growth, and late-seral forest) and mid-seral forest stands were assumed to provide adequate structural conditions for dispersal habitat. A total of 145,532 acres of dispersal habitat occurs on the PALCO lands: late-seral (63,170 acres; and mid seral (82,362 acres) (PALCO 1999).

Other protective measures
Spotted owls are covered by protection measures of the CFPRs. These protective measures are summarized as follows:

1. Determine if the proposed action would result in take of the northern spotted owl.

2. Implement the following measures to avoid take:
    a. Prohibit timber harvest within 500 feet of nest or pair activity center during the breeding season.

    b. Retain roosting habitat within 500 to 1,000 feet of nest or pair activity center.

    c. Retain 500 acres of suitable habitat within a 0.7-mile radius of a nest or pair activity center; less than 50 percent of the area may be under operation in any one year.

    d. Retain 1,336 acres of suitable habitat within a 1.3-mile radius of a nest or pair activity center.

    e. Conform retention areas to natural landscape.

<u>Bald eagle</u>
Species
Numbers and distribution

Bald eagle nest sites are not known to occur on the PALCO lands or in the action area (Table 24) (source: CDFG Bald Eagle Database). Although no observations of bald eagles are recorded on lands owned by the Elk River Timber Company, the bald eagle is suspected to occur on these lands. Nesting bald eagles are unlikely to occur in the future on the PALCO lands in large numbers, based on the size of the nesting population in the regional area. Any nesting population on the PALCO lands would represent a very small percentage of the total, compared to totals in the recovery management unit or range-wide.

Table 24. Comparison of number of eagle pairs at different landscape levels, based on 1997 survey data.

Landscape level	Number of pairs
PALCO lands	0
Action area	0
Regional area[1]	10
Recovery mgt. unit 23	12
California	142
Pacific recovery region	1,359
Lower 48 states	5,170

[1] The regional area is defined as Mendocino, Humboldt, and Del Norte Counties, CA, and Curry County, OR. Data for Mendocino, Humboldt, and Del Norte Counties were based on CDFG bald eagle data base, and data for Curry County was based on Oregon State Bald Eagle Database.

Wintering bald eagles (5 to 11 individuals) have been observed from November to March in various watersheds on PALCO lands: Yager Creek watershed (three to seven eagles); Eel watershed (one to two eagles); and Humboldt watershed (one to two eagles).

Reproduction

No information on reproduction of the bald eagle is available for PALCO lands or the action area, since no nests are documented for either area. Reproduction rates for the bald eagle have met or exceeded recovery goals at the recovery unit and range-wide levels.

Suitable habitat

Acreage

Late-seral forests provide suitable habitat for the bald eagle. For the purpose of this consultation, suitable bald eagle habitat is defined as follows: primary nesting and roosting habitat – all residual old-growth and uncut old-growth stands within 0.5 mile of Class 1 streams; secondary nesting and roosting habitat – all residual old-growth and uncut old-growth greater than 0.5 mile from Class 1 streams; wintering habitat – all late-seral forests, residual old-growth, and uncut old-growth.

Suitable habitat for the bald eagle on PALCO lands is quantified as follows: primary nesting and roosting habitat - 19,792 acres; secondary nesting and roosting habitat - 23,839 acres; and wintering habitat - 69,231 acres (table 25).

Table 25. Acres of suitable bald eagle habitat on the PALCO lands, MMCAs and Headwaters Reserve.

	Land Allocation		
Habitat type	PALCO	MMCAs	Headwaters
Primary nesting/roosting	19,792	1,654	3,115
Secondary nesting/roosting	23,839	5,262	3,783
Wintering	69,231	5,788	5,304

Distribution and quality
Primary nesting and roosting habitat (19,792 acres) is currently distributed throughout the PALCO lands. The distribution of this habitat by WAA is summarized as follows: Bear Mattole - 3,683 acres; Eel River - 5,125 acres; Humboldt Bay - 4,525 acres; Van Duzen - 1,492 acres; Yager Creek - 4,880 acres; and Mad River - 88 acres. The distribution of the other habitat types was not compiled for the purpose of this consultation.

Landscape comparison
A meaningful comparison of the amount of suitable habitat at different landscape levels was not possible due to a lack of appropriate information (e.g., locations of Class I streams and vegetation characteristics) for all levels. Estimates of the amount of suitable habitat for the action area, regional area, and range-wide are not available.

Suitable habitat on the PALCO lands is assumed to occupy less than 1 percent of the total listed range, based on the size (most of the lower 48 states) of the eagle's listed range. Acres within the listed range of the bald eagle were not calculated for the purpose of this consultation.

Factors affecting species and suitable habitat in the action area
Other protective measures
Bald eagles are covered by the CFPRs. These protective measures are further summarized as follows:

1. Retain a buffer of at least 10 acres around active nests. Prohibit clear-cutting but allow commercial thinning, salvage, selection, and shelterwood (except seed tree removal step)

timber harvest prescriptions within the buffer. Retain all designated perch, screening, or replacement trees.

2. Prohibit timber operations within the buffer zone during the breeding season (January 15 to August 15 or four weeks after young leave the nest). Exceptions for hauling on existing roads can be made.

3. Prohibit helicopter yarding within 0.25-mile radius of the nest tree; allow gradual approach of helicopters within 0.5-mile radius of nest tree.

Marbled murrelet

The action area for the analysis of effects on the marbled murrelet is defined as all PALCO lands, including the Headwaters acquisition area. It is important to note that this definition is different from that used for some of the other species addressed in this biological opinion.

Species

Numbers

The Final EIS/EIR provides information on the marbled murrelet population at the following scales: the Bioregion, Recovery Zone 4 (USDI Fish and Wildlife Service 1997), and California. The Bioregion extends from the Mad River south to Shelter Cove and inland 35 miles including the action area. The Bioregion includes public lands in the King Range National Conservation Area, HRSP, and GCSP. Population estimates for California range from approximately 5,000 to 6,000 murrelets (Swartzman et al. 1997, Ralph et al. 1995). The Bioregion population is estimated to be 1,479 murrelets (Swartzman et al. 1997).

The precise number of murrelets occupying the action area is unknown but can be crudely estimated in two simple ways based on available data:

1. First estimate the amount of likely occupied habitat in the action area and in California. Using at-sea survey results for California (Nelson 1997), then estimate the proportional number of murrelets expected in occupied habitat in the action area. Using this method, the FWS estimates there are approximately 1000 murrelets on PALCO lands, including the Headwaters acquisition area.

2. Swartzman et al. (1997, page 12 and Appendix 1) divided the northern California subpopulation into two distinct groups and used local at-sea surveys to estimate the number of murrelets in Bioregion. They estimated 1,479 murrelets occur in the Bioregion. To further apportion murrelets to the action area within the bioregion, the FWS used this figure to estimate that approximately 926 murrelets occur on PALCO lands, including the Headwaters acquisition area.

These two figures likely overestimate of the number of murrelets residing on PALCO lands because the FWS probably underestimates the amount of occupied habitat in HRSP; this issue is discussed later in the section describing the amount of occupied habitat in the Bioregion.

In the SYP/HCP, Ralph et al. conclude that the northern California marbled murrelet population appears stable. In contrast, a recent analysis of this data on population trend found stable populations offshore the Redwood National Park region and declining populations offshore of the northern Del Norte region (6.6 percent per year) and the Bioregion (13.3 percent per year) (Stanley 1998). This report shows yearly declines of 7.9 percent for the northern California population with a cumulative decline from 1989-1997 of 48 percent. A rate this high seems unlikely to have gone unnoticed by field researchers (USDI Fish and Wildlife Service 1997, page B-18), but most at-sea survey designs currently in use have a low power to detect declines of these magnitudes because of low statistical power (Becker et al. 1997). Murrelet movements north and south within the northern California remain unknown and further confound interpretation of the data. The Stanley (1998) analysis is a draft currently being peer reviewed for publication and the Ralph et al. analysis (SYP/HCP) has not been adequately reviewed. Until these analyses receive acceptable peer review and their conflicting conclusions are addressed, the FWS will continue to rely on the demographic modeling conducted by the Recovery Team (USDI Fish and Wildlife Service 1997, Appendix B) as the best available information concerning murrelet population trends. These authors concluded that the murrelet is most likely declining at rates of between 4 and 7 percent per year, with the possibility that sharper declines may be occurring in some localized areas.

Distribution

For the purposes of calculation at the landscape level, both of these population estimation methods assume that murrelets occur homogeneously within all occupied habitat within the action area, Bioregion, Zone, and listed range. When evaluating distribution at the scale of the forest stand, it is more reasonable to assume that murrelets occur differentially in occupied habitats in amounts that reflect habitat quality, occurring in higher densities and/or achieving greater reproductive success in good habitat and in lower densities with lower success in poorer habitats (Ralph et al. 1995, Swartzman et al. 1997, pages 13-14, 18-19). For example, it is logical to assume that murrelets occur in the action area in greater densities in high quality habitat such as the Allen Creek stand and in lower densities in lower quality residual redwood stands such as "Turkey Foot," even though both stands are categorically classified as "occupied" (Swartzman et al. 1997, page 13). It is important to note that residual old-growth redwood stands "exhibit a wide range of potential suitability for murrelets, with some resembling old-growth, some resembling clear cuts with a few large trees left standing, and some in between" (Swartzman et al. 1997, pgs. 13, 18-19).

However, we have no reliable information with which to apply a meaningful measure of these habitat differences, relate this measure to murrelet densities and distribution, and calculate precise estimates of murrelet numbers on a site specific basis. This issue of differential habitat quality is discussed later in this opinion.

Most of the known occupied stands are located in the northern part of the action area. However, smaller stands of relatively isolated old-growth habitat containing murrelets are scattered across PALCO lands, with several occupied stands located in the southern part of the SYP/HCP area adjacent to HRSP and GCSP.

Reproduction
There is no quantitative data available on marbled murrelet reproductive success in the action area. As discussed above, it is likely that reproductive success is higher in high quality habitat and low in lower quality habitat. The specific habitat features that affect reproductive success, such as canopy cover and stand size, are discussed in the Suitable Habitat section below.

Suitable Habitat
In development of this Environmental Baseline, the FWS has observed some inconsistencies with the habitat acreage estimates in the various publications describing the SYP/HCP and in recent revisions or new information updates. All of these observed inconsistencies are small (on the order of 1-3 percent), and are unlikely to negatively affect the FWS's ability to describe the impacts of the SYP/HCP. Small discrepancies in acreage totals between different tables are most likely due to variation in GIS estimates and calculations or to small errors in some source data; also, there were revisions to the SYP/HCP made in December, 1998, which placed more habitat into reserve areas. The FWS resolved most of these discrepancies in the course of developing this biological opinion.

Most of these revisions occur in the following areas: PALCO has completed review of data from 1998 field work and has provided more information to the agencies concerning (1) the amount of known or likely occupied habitat in HRSP, (2) the amount of potentially suitable residual old-growth redwood habitat that has been field verified to actually be suitable or unsuitable, and (3) some additional suitable residual old-growth redwood that has been surveyed to PSG protocol (Ralph et al. 1994) and determined to be either occupied or unoccupied by marbled murrelets.

To estimate the total amount of potentially suitable murrelet habitat on PALCO lands (including Headwaters acquisition area), the Service updated the analysis (T. Reid, pers. comm., January 11, 1999, Appendix 1) and incorporated the December, 1998, additions to conservation areas; we conclude there are 26,105 acres of suitable murrelet habitat on PALCO's ownership. The FWS has received recent information from PALCO further updating this analysis with results from 1998 field surveys (S. Chinnici, January 19 and January 25, 1999). Ground surveys revealed that 1,837 acres of residual redwood was not suitable murrelet habitat; this number was subtracted from the 12,447 acres of this type in Appendix 1. This information was reviewed and confirmed by the agencies. Applying these updated figures, approximately 24,268 acres of potentially suitable murrelet nesting habitat occurs on the PALCO lands (including the Headwaters acquisition area), which is about 11 percent of the total ownership. The remainder of the forest on PALCO lands, such as late-seral forests that lack a residual old-growth component, is not considered potentially suitable murrelet habitat (although impacts to some of this acreage, if contiguous with suitable habitat, could affect the marbled murrelet if not adequately buffered).

Estimate of Different Types of Suitable Habitat
Marbled murrelet suitable habitat in the SYP/HCP area can be divided into three general habitat types: unentered old-growth redwood (UOG), residual old-growth redwood (ROG), and old-growth Douglas-fir (DFOG) (Table 26). Old-growth redwood or Douglas-fir stands that are determined by the company and the agencies to not be suitable murrelet habitat, such as the 1837 acres described above, are not included in this discussion.

Table 26. Acreage estimates of potentially suitable marbled murrelet habitat on PALCO ownership and the Headwaters acquisition area in three habitat types: unentered old-growth redwood (UOG), residual old-growth redwood (ROG), and old-growth Douglas-fir (DFOG). Data from Appendix A.

	UOG	ROG	DF	Total
Acres	5,139	10,610[1]	8,519	24,268

[1] Appendix 1: 12477 - 1837 (S. Chinnici, January 25, 1999) = 10,610

Unentered Old-Growth Redwood: The FWS defines UOG as those stands of old-growth redwood from which commercial timber has not been removed. Of the 5,139 acres of UOG, the largest stands are primarily found in the northern third of the PALCO property (see Final EIS/EIR map at figure 3.9-2). The largest contiguous block of UOG is the Headwaters Forest (including the Elkhead Springs stand), which contains about 3,117 acres of UOG (61 percent of the UOG on the property). The remaining UOG stands often contain over 30 old-growth trees per acre and, although small openings do occur, often exhibit 80 to 100 percent canopy closure.

Residual Old-Growth Redwood: The FWS defines ROG as those stands of old-growth redwood from which commercial timber has been selectively removed at some point in the past. Stands of potentially suitable ROG, in which varying numbers of old-growth trees remain after selective harvest, occupy approximately 10,610 acres. These residual stands are widely scattered across PALCO lands (see Final EIS/EIR map at Figure 3.9-2), and many have been internally fragmented by recent clear-cutting. About 96 percent of the residual stands contain fewer than 15 old-growth trees per acre.

Old-Growth Douglas-fir: The FWS defines DFOG as those stands dominated by old-growth Douglas-fir and from which commercial timber has or has not been removed. There are approximately 8,519 acres of potentially suitable DFOG stands on the ownership. This habitat is relatively drier and has more of a hardwood tree component than the UOG and ROG redwood stands. Although much of this habitat appears to be suitable for marbled murrelet nesting, murrelet surveys of this habitat (46 percent of the 8,519 acres has been surveyed) revealed low occupancy rates (approximately 5 percent). This is discussed below in the section that addresses the amounts of occupied acreage on PALCO lands.

Estimate of Occupied Habitat on PALCO Ownership (including Headwaters)
PALCO forest stands have been surveyed for marbled murrelets to varying degrees. Some areas are known to be occupied, some are known to be unoccupied, others are partially surveyed, and still other areas have not been surveyed and may not even be suitable nesting habitat when field inspected. The Service used the following steps to estimate the total amount of PALCO acreage that is likely to be occupied by nesting murrelets:

1. Tabulate the acreage known to occupied, known to be unoccupied, and incompletely surveyed or unsurveyed (Table 27).

2. Segregate by general habitat type (i.e., UOG, ROG, DFOG)

3. Use an occupancy index, calculated from stands within each habitat type with completed surveys, and apply this index to the unsurveyed acreage; this figure is the "likely occupied."

4. Add the known occupied and likely occupied to get an estimated total occupied for each habitat type.

Prior to conducting marbled murrelet surveys in a timber stand, an assessment is conducted regarding the suitability of the habitat and a final determination is made by company biologists, consultants, and agency biologists. If the habitat is determined to be suitable (i.e., it contains the requisite habitat features to allow murrelet nesting), surveys are conducted. If the habitat is deemed unsuitable, surveys are not conducted. Appendix A describes the respective amounts of UOG, ROG, and DFOG habitat types that have been surveyed. Although survey effort was not applied in a totally consistent manner across all areas due to logistical concerns, the FWS believes these data are statistically adequate to arrive at general conclusions concerning the respective rates at which unsurveyed DF, ROG, and UOG are likely to be occupied (Marbled Murrelet Recovery Team, November 30, 1998; S. Chinnici, PALCO, pers. comm., January 19, 1999).

As described in table 27, there is a significant amount of potentially suitable murrelet habitat in the ROG and DF types that, through field examination, has not yet been determined to be occupied or unoccupied by murrelets. Nevertheless, harvest of some of this habitat is part of the proposed action. Likewise, there is a large area of potentially occupied habitat in the Bioregion but not on PALCO ownership (e.g., in HRSP) that has not been adequately surveyed to determine whether it is occupied by murrelets.

Because removal of suitable habitat could adversely affect the murrelet and removal of occupied habitat could result in take of murrelets, the Service believes it is reasonable to use rates of suitability and occupancy derived from surveyed habitat to estimate the amounts of unsurveyed habitat that are likely unoccupied and occupied (Ralph et al. 1995, page 18). The Service discussed with biologists from PALCO and CDFG the appropriateness of applying occupancy rates to unsurveyed areas, and it was agreed by field biologists that such an approach was reasonable.

This approach, which has been applied in other murrelet HCPs (e.g., Elliott State Forest HCP), is justified provided two related conditions are met:

> The survey effort expended in the habitat types with known outcome was sufficient to constitute representative samples of those habitat types, so that the resulting rates incorporate and reflect within-type variation;
>
> The unsurveyed stands to which these rates will be applied are from the same "population" or habitat stratum from which the respective rates were derived.

Although the PALCO survey effort was not originally designed to address this statistical need, the Service believes that both of these conditions are adequately met (Marbled Murrelet Recovery Team, November 30, 1998). Since the murrelet was listed, PALCO has surveyed approximately 46 percent of the DFOG type and over 87 percent of the ROG type. This level of survey effort is very likely to capture the within-type variation that exists on the ownership, assuming all or a great majority of the survey effort was not concentrated in a particular geographic area or some unique subset of the habitat type. PALCO has informed the FWS that the survey effort should be considered as representative samples of the respective habitat types; if a bias does exist, according to PALCO it is biased towards overestimating murrelet use of all residual stands (S. Chinnici, pers. comm., January 19 and January 25, 1999).

Table 27. Acreage estimates of occupied, unoccupied and potential but unsurveyed murrelet suitable habitat on PALCO lands (including the Headwaters acquisition area) proposed for harvest or protection, respectively. Data from Final EIS/EIR, Appendix N2, Tables 3A and 5A, and Appendix A (as updated by P. Detrich, USFWS, pers. comm., January 2, 1999, T. Reid, pers. comm., January 11, 1999, and S. Chinnici, PALCO, pers. comm., January 19 and January 25, 1999). Adjustments of 1-2 percent were made to some figures to reconcile slightly different estimates from the various tables.

Habitat Type	Occupancy Status	Acres
Unentered Old-Growth Redwood (UOG)	Occupied	4,230
	Unsurveyed	909
	Unoccupied	0
	Subtotal	5,139
Residual Old-Growth Redwood (ROG)	Occupied	5,517[1]
	Unsurveyed	4,717[2]
	Unoccupied	376[3]
	Subtotal	10,610[4]
Old-Growth Douglas-fir (DFOG)[5]	Occupied	190
	Unsurveyed	4,563
	Unoccupied	3,766
	Subtotal	8,519
TOTAL ACRES		24,268

[1] Table 5A

[2] Table 5A: 10610 - 5517[1]= 4717

[3] 376 (unoccupied per S.Chinnici, pers. comm., January 25, 1999)

[4] Table 7A (1/11/99): 12,447 - 1,837 (unsuitable per S.Chinnici, pers. comm., January 25, 1999) = 10,610

[5] Table 5A

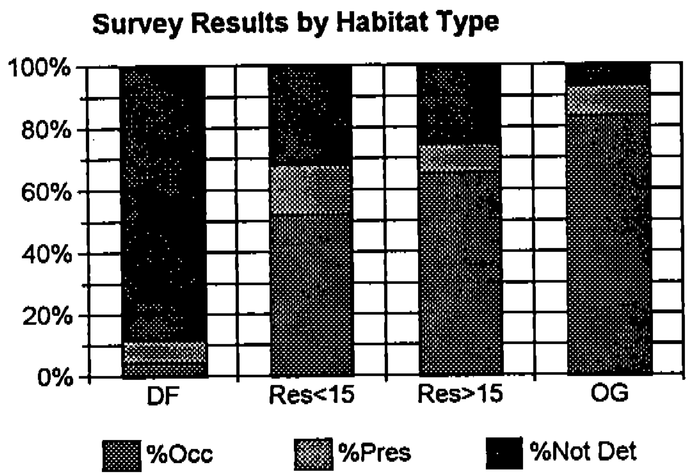

Figure 1. Percentage area determined to be occupied, present, or not detected for DF, ROG (<15 old-growth trees/acre), ROG (>15 old-growth trees/acre), and UOG habitats that have been surveyed to accepted PSG standards (Ralph et al. 1994).

Applying likely occupancy rates for the three habitat types, table 28 describes the amounts of the unsurveyed habitat that are likely occupied and unoccupied by applying the respective habitat type occupancy indices. Combining these results with the known occupied acreage, table 29 describes the total amounts of known or likely occupied habitat on PALCO lands (including the Headwaters acquisition area).

The following acres of habitat on PALCO lands (including the Headwaters acquisition area) are known to be occupied: 4,230 acres of old-growth redwood, 5,517 acres of residual redwood, and 190 acres of Douglas-fir (Final EIS/EIR, Appendix N2, table 5A). Using occupancy rates derived from this surveyed habitat, the Service estimates there are an additional 910 acres of occupied old-growth redwood, 2,343 acres of occupied residual redwood, and 228 acres of occupied Douglas-fir.

Table 28. Estimates of unsurveyed habitat that is likely occupied and unoccupied by applying occupancy indices derived from surveyed area results on PALCO (including the Headwaters acquisition area).

	Unentered Old-Growth Redwood	Residual Old-Growth Redwood		All Old-Growth Douglas-Fir Dominant
		> 15 OG trees/acres	< 15 OG trees/acre	
Unsurveyed Acres	910	212*	4505*	4563
Occupancy Index	1.0^	0.66	0.52	0.05
Estimated Occupied Acres	910	140	2343	228
Estimated Unoccupied Acres	0	72	2162	4335

*Of the total 4717 acres of ROG, it was unknown exactly how much was <15 trees/ac and how much was >15 trees/ac. We used the overall estimate of 4.5 percent ROG is >15 trees/ac from Appendix 1.

^Occupancy index of 1.0 was applied here because remaining unsurveyed UOG is continuos or proximal to occupied habitat and almost certain to be occupied.

Quality

Distinguishing high quality habitat from low quality habitat is difficult for this cryptic and secretive species. The best measures of habitat quality would be those that describe actual life history parameters important to the species, such as reproductive success or nesting attempts per unit area (Grenier and Nelson 1995, page 201; Hamer and Nelson 1995, page 80). Unfortunately, these types of data are lacking for PALCO lands and for most of the species' range (Ralph et al. 1995, page 8), a situation especially common on private lands (Hamer 1995, page 173). Because of the logistical difficulty and expense in collecting these data, researchers are beginning to collect other measures of habitat quality specific to the murrelet, such as density and availability of nesting platforms. However, these data are also not currently available.

Table 29. Total acres of likely occupied murrelet habitat in UOG, ROG, and DF habitat types on PALCO ownership (including the Headwaters acquisition area).

	Unentered Old-growth Redwood	Residual Old-Growth Redwood > 15 OG trees/acres	Residual Old-Growth Redwood < 15 OG trees/acre	All Old-growth Douglas-fir Dominant	Total Occupied Acres
Known Occupied Acres	4,230	248	5,269	190	9,937
Estimated Additional Occupied Acres	910	140	2,343	228	3621
Total Likely Occupied Acres	5,140	388	7,612	418	13,558

Therefore, the FWS used available information to assess the relative quality within and between the UOG, ROG, and DFOG habitat types on PALCO lands (including the Headwaters acquisition area), including data on murrelet occupancy surveys, timber volume, a combined measure of canopy closure and subcanopy (height of second growth trees), and stand size or configuration. The Service acknowledges that use of these indirect measures has some limitations. But as described below, cautious inferences concerning habitat value can be drawn from these measures, and the FWS believes these data are the best available information to address this issue (Ralph et al. 1995, page 18; Swartzman et al. 1997, pages 13-14).

Occupancy survey data as a measure of habitat quality: The FWS believes that PSG (Ralph et al. 1994) survey data in the different habitat types can give insight into the relative value of various habitat, but such inferences should be made conservatively (Burger 1995, pages 158-161). The observation of occupied behaviors indicates that a timber stand is likely used by marbled murrelets for nesting (Ralph et al. 1995). Occupancy determinations may be made at different rates for different habitat types, suggesting that these habitats are preferred or utilized by murrelets at different rates.

Some consultants hired by PALCO believe that gross numbers of murrelet presence or occupancy detections from PSG surveys give reasonable insight into the relative value of different stands with differing rates of murrelet detections (Ralph et al. in SYP/HCP, Volume IV, Part B, Section 9). These consultants used a "relative bird value" (RBV) calculation and concluded that most of the murrelets in the Bioregion occur in the Headwaters stand and HRSP, and relatively few birds occur in potential harvest areas.

As the FWS expressed previously to PALCO and its consultants (USDI Fish and Wildlife Service, pers. comm., February 28, 1997), we do not agree that absolute or relative numbers of detections can be used at this time to accurately assign quantitative relative value to individual stands. Due to the difficulty in detecting murrelets and the possibility that multiple observations of the same bird could give misleading estimates (Cooper and Blaha 1998, Cooper et al. 1998), other researchers reject this approach as unjustified (Paton 1995, page 116, S.K. Nelson, pers. comm., October 31, 1997). The FWS believes that PSG survey results can be used to assess relative habitat quality by ascribing *categorical* designations to various stands (e.g., "occupied" or "unoccupied"), which in turn can be organized by stand type to derive relative rates of occupancy. This approach does not allow the quantitative use of detections to further discriminate between the different habitat types, as well as between stands within the same habitat type. We believe the "RBV" approach may have merit for future research and monitoring efforts if certain statistical and logistical problems can be reduced.

Although there may be some overlap in quality between the types, figure 1 illustrates that UOG is on average occupied by murrelets at a higher rate than all other habitat types, and both types of ROG redwood are occupied at greater rates than the DFOG. All other stand characteristics being equal (e.g., stand size, shape, and degree of fragmentation), and assuming that murrelets are preferentially selecting certain stands to nest in (and exhibit occupied behaviors) and are avoiding less desirable habitats, it is reasonable to conclude that UOG is likely the more preferred habitat and is of relatively greater value to the species. This conclusion is consistent with the general hypothesis and supporting research suggesting that stands with more old-growth trees provide more nesting opportunities and better cover from predators and adverse weather (Ralph et al. 1995, page 7; Swartzman et al. 1997).

Due to the low occupancy rates (about 5 percent) for the DFOG type described above, the data suggest that this habitat type is used by murrelets at very low levels. This observation is consistent with observations of Douglas-fir suitable habitat elsewhere in portions of California (Hunter et al. 1998). Known nest sites in California have a higher percentage of redwood trees than Douglas-fir even though some nests in these stands were in Douglas-fir trees (Hamer and Nelson 1995, page 75; Swartzman et al. 1997). Therefore, the FWS concludes that the DF habitat type has limited value to the murrelet on PALCO lands, and the following discussion of other habitat quality indicators focuses on UOG and ROG redwood types only. (However, we did include estimates of occupied DFOG habitat in the section describing Effects of the Action.)

Volume and stem density as an indicator of habitat quality: Absent any quantitative information on the PALCO ownership regarding specific murrelet habitat attributes such as nest platform density, the FWS analyzed timber volume density as a surrogate indicator. Although this type of measure is indirect and may be relatively imprecise (Hamer and Nelson 1995, page 80), it makes use of the best available information and will give useful insight (Hamer 1995, page 173). In proceeding with this analysis, the FWS generally assumed that the greatest volume density occurs in stands with the largest number of the largest old-growth trees, and that these stands in turn are likely to have the greatest number of large limbs suitable for murrelet nesting. Thus, as a general hypothesis, murrelet nesting opportunities should be higher in old-growth stands with greater volume and proportionately lower in stands with less volume. Although the FWS is unaware of any empirical studies that demonstrate a positive linear relationship between volume density and nest platform density, this approach is consistent with conclusions from the murrelet scientific literature. For example, Burger (1995, page 158) found that occupied detections were positively correlated with mean tree diameter and basal area, and Hamer (1995, page 174) suggested that stem density may be associated with higher rates of successful murrelet nesting.

Timber volume density varies markedly between the two redwood habitat types (Final EIS/EIR, Appendix N2, table 1.B). About 28 percent of the acres of ROG stands contain less than 25 mbf/ac, about 68 percent contain between 25 and 50 mbf per acre, and about 4 percent contain more than 50 mbf/ac. In contrast, about 90 percent of UOG stands exceed 100 mbf per acre, and 50 percent exceed 150 mbf per acre.

Canopy closure and second growth subcanopy as a measure of habitat quality in residual stands: Canopy closure and the height of second growth subcanopy is another potential measure of current and future murrelet habitat quality (Swartzman et al. 1997, page 14). In general, the agencies assume that the best habitat in ROG stands would be provided where the highest timber volume and high canopy closure among the residual overstory (which would result from higher density of large residual trees and/or large limb structure) are combined with maximum height of the second-growth stand beneath the residual overstory. Miller and Ralph (1995, page 212) found that occupied stands had higher percentages of old-growth cover than stands with presence only or no detections. Areas with higher canopy closure provide cover from predators and adverse weather conditions for nesting murrelets (Nelson and Hamer 1995a, page 66). Vertical cover, such as that provided by second growth, may also provide cover from predators or elements (Grenier and Nelson 1995, page 199). Although recent research is continuing to investigate the relationship between canopy and murrelet nesting success (e.g., there may some value to small openings in the canopy to allow murrelets access to nest limbs (Grenier and Nelson 1995, page 199)), researchers suggest that higher rates of canopy closure and vertical stem density may be associated with higher rates of successful murrelet nesting (Swartzman et al. 1997, page 14; Hamer 1995, page 174; Hamer and Nelson 1995b, page 80; Marbled Murrelet Recovery Team, 1998).

Most of the residual stands have relatively low canopy closure because a relatively small number of large trees remain. About 59 percent of the residual acres on PALCO lands (including the Headwaters acquisition area) have a canopy closure of less than 25 percent, and less than 2 percent of the residual acres have canopy closure over 50 percent (Appendix N1, Final EIS/EIR). Most known murrelet nests in redwood stands are over 120 feet above the ground (n=10, mean= 154 feet, SD=36 feet, range 108-223 feet) (Hamer and Nelson 1995b), so surrounding second growth should exceed that height to provide protective cover. Where the overstory residual trees are sparse, or where the understory second-growth does not reach above 120 feet in height, habitat for murrelets is assumed to be of lower quality. Under very good conditions, some young dominant redwoods may exceed 120 feet at 40 years of age, but most stands would be expected to grow somewhat slower than this rate (Lindquist and Palley 1963 cited in Appendix N1, Final EIS/EIR).

Although conditions vary, on the PALCO ownership it is reasonable to expect that most second-growth redwood stands on the ownership would not exceed 120 feet in height until they are over 60 years of age (T. Robards, pers. comm.). Because the partial harvest in many of the residual stands occurred in recent decades, there are few remaining residual stands where the second-growth exceeds 100 feet in height; about 695 acres of such stands (less than 6 percent of total ROG) exist on PALCO lands (including the Headwaters acquisition area). In other stands totaling about 4,036 acres (32 percent of the residual stands), the second growth beneath the residual trees is now between 60 feet and 100 feet in height.

Relative stand size as a measure of habitat quality: The FWS evaluated the significance of stand size as another possible indicator of habitat quality. The potential relationship between forest fragmentation, edge, stand size, and adverse effects on forest nesting birds has received increased attention during the last few decades. In a comprehensive review of the many studies on this topic, Paton (1994) concluded that "strong evidence exists that avian nest success declines near edges."

Small patches of habitat have a greater proportion of edge than do large patches of the same shape (Schieck et al. 1995). Although murrelets can nest successfully in small stands (USDI Fish and Wildlife Service 1997), murrelet occupancy rates are generally higher in larger stands. It is believed that larger stands with less edge are likely to have greater rates of murrelet nest success due to reduced predation (Burger 1995, page 158; Nelson and Hamer 1995b, page 96; Swartzman et al. 1997, page 18). In the only direct measure of marbled murrelet reproductive success, Nelson and Hamer (1995b) found that successful murrelet nests were further from edge than unsuccessful nests. They also found that successful murrelets tended to nest in larger stands than did unsuccessful murrelets, but these results were not statistically significant. Miller and Ralph (1995) compared murrelet survey detection rates among four stand size classes in California. Recording a relatively consistent trend, they observed that a higher percentage of large stands (33.3 percent) had occupied detections when compared to smaller stands (19.8 percent), while a greater percentage of the smallest stands (63.9 percent) had no presence or occupancy detections when compared to the largest stands (52.4 percent) (Miller and Ralph 1995). However, these results were not statistically significant, and the authors did not conclude that murrelets preferentially select or use larger stands. Schieck et al. (1995) found that murrelet presence and abundance were positively correlated with old-growth stand size in British Columbia, but their data were not statistically significant.

Table 30 shows the number and size of old-growth and residual redwood stands, while Figure 5B (Appendix N2, Final EIS/EIR) displays the location of these stands on the ownership. The Effects of the Action section will discuss the difference in size between the harvested and protected stands.

Table 30. Number of discrete unentered and residual old-growth redwood stands in different acreage size classes on PALCO lands (including the Headwaters acquisition area). Douglas-fir habitat type included where contiguous to redwood stands.

Stand Size (ac.)	No. Stands
<5	208
5-9	52
10-49	117
50-99	16
100-199	12
200-300	9
>300	13
Total No. Stands	427

Summary of relative habitat quality: In general, unentered old-growth redwood (UOG) stands are higher quality nesting habitat than stands of residual old-growth redwood (ROG), which in turn are of high quality relative to stands of old-growth Douglas-fir (DFOG). However, without data on productivity within the three habitat types, it is impossible at this time to quantify the relative magnitude of these differences. There is likely some overlap between the high and low ends of these respective habitat types (e.g., depending on the specific habitat measure, some lower quality UOG may be similar in value to the murrelet as some high quality ROG), but overall there are probably significant differences in value between these respective habitat types (Swartzman et al. 1997, Marbled Murrelet Recovery Team 1998). The Effects of the Action section will discuss differences in quality between those areas proposed for harvest and those proposed for conservation.

Marbled murrelet critical habitat

Number and acreage of units

Most of the analyses in this biological opinion are based on the action area(see the description of the proposed action for discussion of the action area. Other analyses of effects on the marbled murrelet in the Final EIS/EIR and this biological opinion are based on the so-called southern Humboldt bioregion. Boundaries of CHUs are bisected by the boundaries of both of these scales of analysis; so, to avoid confusion, the following discussion does not precisely conform to the defined action area or the southern Humboldt bioregion, but instead directly applies to those six CHUs or discrete portions of CHUs that are within the vicinity of the action area. These local CHUs were described in Table 15 above.

The area encompassed within the six CHUs in proximity to the action area constitutes about 14 percent of the total acreage within CHUs in Conservation Zone 4, and about 3.5 percent of the acreage within the three-state range. Habitat with primary constituent elements in the CHUs near the action area is estimated to constitute about 14.9 percent of the habitat within CHUs in Conservation Zone 4, and about 3.5 percent of the suitable habitat within CHUs within the three-state range.

Forest stands designated as critical habitat in the action area include three types: uncut old-growth, residual old-growth, and young forest where the average height exceeds ½ the site potential tree height and that is within ½ mile of uncut or residual old-growth. On most of the PALCO property, which is Site Class 2, the site potential tree height is estimated to be 218 feet. Because available forest inventory data for the PALCO ownership that includes tree height is available only in small polygons that are not easily aggregated for analysis, growth equations were used to predict an average stem diameter equivalent to ½ the site potential tree height. (For details on determination of site potential tree height and associated stem diameters, see Appendix B.) The average stem diameter of stands with an average height of ½ the site potential tree (i.e., 109 feet) is about 24 inches. Coincidentally, that diameter represents the division point between two CWHR classes, late-seral and mid-seral, which are classified in the PALCO data base and analyzed in the Final EIS/EIR and elsewhere in this opinion. Therefore, where stands classed as CWHR late-seral occur within ½ mile of old-growth or residual stands, they are counted as critical habitat for this analysis.

Approximately 2,786 acres of this late-seral critical habitat exists in the project area within CHU-CA-03-a. This constitutes about 23 percent of the actual critical habitat acres in the CHU. Of this late-seral total, 1,745 acres are on Eel River Timber Company lands, mostly adjacent to the Headwaters old-growth stand, and 1,041 acres are on PALCO lands. Because these forests are too young for the trees to produce large limbs, this habitat does not provide nesting substrate for marbled murrelets, but it is believed to provide protection from effects of predation and weather on nesting habitat in neighboring old-growth stands.

Factors affecting primary constituent elements

Other protective measures

Currently, critical habitat in the action area is subject to varying degrees of protection. On HRSP and GCSP, no timber harvest or other habitat removal occurs, although facilities such as campgrounds and trails may affect habitat quality. On BLM lands, all CHUs are allocated as LSRs, where timber harvest may only occur to enhance attainment of late successional characteristics. On private lands, if habitat is occupied by murrelets, it is protected under the CFPRs, CESA, and ESA. However, if critical habitat on private lands is not occupied by murrelets, there are no specific murrelet-related protections for habitat under state or federal law, unless a federal action is involved that must be evaluated under section 7 of the Act. Thus, under existing conditions, unoccupied critical habitat in old-growth, residual, or young forest on private lands may be harvested, with the exception of 300-foot protective buffers applied around occupied habitat to avoid take of murrelets. As a result, there probably has been some ongoing decline in lower quality, unoccupied critical habitat on private lands in the action area. The degree of this decline is unknown.

Western snowy plover

Species

Numbers and distribution

Within the action area, snowy plovers recently were found to nest on gravel bars along the lower Eel River in Humboldt County, California, the first documented nesting of snowy plovers on river gravel bars in the western U. S. (Tuttle et al. 1997). These locations are about several miles down river from PALCO property. Intensive surveys, mostly associated with ongoing commercial gravel extraction operations on the lower Eel River, have been implemented to ascertain the seasonal and spatial use of the lower Eel River. These surveys cover ten large gravel bars representing several hundred acres on approximately 8 river miles between the mouth of the Van Duzen river to the downstream end of Singley Bar near the end of Fulmor Lane in Ferndale, California. The primary purpose of these surveys is to monitor plover use of gravel bars, relative to existing gravel mining operations, and to quantify the current distribution of the species on the Eel River. Survey data indicate plovers occur on nearly all large gravel bars in the study area and nest on several of the largest gravel bars. Reconnaissance-level surveys conducted on the Eel River upstream from the mouth of the Van Duzen River have not detected any plovers. Several agencies under the coordination of CDFG have conducted surveys on 12 nesting areas on ocean beaches or sand spits of coastal bays and lagoons. Currently there are no documented occurrences of western snowy plovers on PALCO's ownership.

Reproduction

Based upon data accumulated from surveys, the Eel River population represents the largest concentration of snowy plovers between Point Reyes, California and the Oregon border. Approximately 12 to 15 plovers were seen during the 1996 study, 20 birds were found during 1997, and as many as 28 were detected in 1998. At least 16 nesting pairs were located in 1997 along river bars; in 1998, a total of nine nests were located. Ten of the 16 nests found during 1997 were monitored; seven hatched at least one chick. Of nine nests reported from Eel River gravel bars in 1998, two were documented as hatching. Additional breeding pairs may occur on the Eel River, given available suitable nesting habitat and observations of young not associated with known nests. In contrast, only two coastal breeding sites were known to have nesting plovers during 1998; these two sites produced one nest each, both of which failed to hatch.

Suitable habitat

Within Humboldt and Del Norte Counties, 13 areas with historic nesting and wintering use have been identified, for a total of 6,341 acres on 60.5 miles of coastal beach, which represents 14.6 percent of all acres and 13.3 percent of the miles of potential suitable habitat within the three-state listed range area. The largest gap of potential suitable habitat for the western snowy plover exists along the California coast from south central Humboldt County to central Sonoma County. Within this approximately 200-mile coastline, only two known areas of suitable habitat are identified: McKerricker Beach and Manchester Beach. Although snowy plovers were reported to move several hundred miles between breeding and wintering areas, plovers tend to be relatively faithful to sites used as breeding grounds between years. However, at least one record exists of a female plover moving more than one hundred miles between nest sites in one nesting season. This degree of fidelity suggests some plovers in Humboldt and Del Norte Counties may be reproductively isolated from those in central and southern California.

The amount of suitable habitat on the action area (i.e., suitable gravel bars of the lower Eel River) is not precisely known but is estimated to be several hundred acres. Suitable habitat is associated with the most open gravel bars along the banks of the Eel River from the mouth of the Van Duzen downstream to at least the lower end of the Singley bar below Fernbridge. The amount of the gravel that is suitable substrate is unknown. Currently no gravel bars on PALCO lands within the action area that have characteristics of suitable habitat are known to be occupied by snowy plovers.

Landscape comparison
The baseline to be used for the analysis of western snowy plover effects is the gravel bars of the lower Eel River. The gravel bars of the lower Eel River (i.e., all suitable habitat within the action area) contain only a small portion (less than 2 percent) of the total suitable habitat for the western snowy plover within the species range, and approximately 15 percent of the suitable habitat within Humboldt and Del Norte Counties. However, based on recent surveys, gravel bars in the action area provide a very high percentage of the nesting effort within the two-county area. In addition, gravel bars on the lower Eel River produced the only known successful nests of plovers in the two counties during the 1998 nesting season.

Within the species range on the Pacific coast, the lower Eel River is the only known location where snowy plovers commonly nest on river gravel bars. This is thought to be, in part, due to the large size, very flat topography, and sparse vegetation on these gravel bars when compared to nearly all other river systems within the species range.

Factors affecting the species and suitable habitat in the action area
Other completed or contemporaneous actions
Currently, several major commercial and one governmental (Humboldt County Department of Public Works) gravel extraction operations are being implemented on the lower Eel River downstream from the mouth of the Van Duzen River. In total, approximately 400,000 cubic yards of gravel and sand are extracted from the these bars annually, with up to 1.6 million cubic yards permitted under existing regulatory authority. As a condition of the permits under which these activities are conducted, all gravel bars must include a pre-operations topographic survey, and all operational areas must be graded to pre-operations contours at the end of each annual extraction period.

Other protective measures
Snowy plover protection measures that are currently in place on these gravel extraction areas call for annual operations to begin after September 15 (considered to be the last day of the local nesting season). Operations may begin as early as August 16 only if intensive protocol surveys indicate that no plovers are nesting or rearing broods on bars on which proposed gravel extraction

activities occur. If plovers are detected, no activities may occur within 1,000 feet of plover nests or broods.

Southern Oregon/Northern California Coast ESU coho salmon

Within the action area, coho salmon have been documented during this decade in Freshwater Creek, Elk River, Mattole River, and the Eel River (including Van Duzen River and Yager Creek). The Final EIS/EIR estimates there are approximately 66 miles of habitat suitable for coho salmon within the Plan area. Based on historical observations, the Final EIS/EIR provides general information on estimates of coho abundance within the action area. For example, the South Fork Eel River is reported as probably supporting the largest remaining natural spawning population in California (CDFG 1994). In the 1989 to 1990 spawning season, less than 300 adult coho salmon spawners were counted in the South Fork, which is believed to represent a maximum population estimate of about 1,320 adults (CDFG 1994). Similarly, adult coho salmon in the Mattole River number less than 800 fish annually, a number much reduced from historic levels (CDFG 1964). Recent observations in tributaries of the Van Duzen found only a few (less than four) adults in any one year. Brown et al. (1994) estimated that Elk River supports a run of about 400 native salmon and recent reports indicate that Freshwater Creek and Elk River currently support viable populations. Overall, the general trend is for fewer coho salmon in most streams in the action area, with some streams that may be maintaining or increasing populations (e.g., Freshwater Creek or Elk River).

In Freshwater Creek, the Humboldt Fish Action Council (HFAC) downstream migrant traps in 1996 captured 922 0+ coho salmon on the mainstem. Traps set up in various Freshwater Creek tributaries also caught coho salmon in 1996 (IFR 1998). Downstream migrant traps provide information about community structure, but are not statistically robust and therefore cannot be used to determine population trends. According to the Final EIS/EIR, carcass surveys conducted by CDFG found 925 adult coho salmon in the North Fork of the Elk River and 14 adult coho in the Yager Creek watershed (CDFG 1995). The same surveys by CDFG found coho salmon carcasses in the Van Duzen River watershed and the Eel River watershed. Electrofishing surveys completed by CDFG in 1991-1993 found a few coho salmon in Stevens Creek, a tributary to the Van Duzen River, and in tributaries to the lower Eel River, but did not find any coho salmon in Yager Creek, in the lower mainstem of the Eel River, in other tributaries to the Van Duzen River, or in tributaries to the Mattole River (IFR 1998). Community structure surveys, such as these electrofishing surveys completed by CDFG, provide an indication of what species may be present in a given area, but are not rigorous enough to definitively establish absence. The Mattole Salmon Support Group (MSG) estimated for 1997 an annual coho salmon adult return of 300 fish to the Mattole River (MSG 1997).

PALCO has released coho salmon from their hatchery program into the Eel River and Humboldt WAAs. According to the Final EIS/EIR, PALCO planted 10,655 coho salmon in the Eel WAA in 1983. The Final EIS/EIR also reports that 174,462 coho salmon have been planted in the Freshwater and Elk River drainages since 1965.